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(54) Title: SYNTHETIC PEPTIDES AND USES THEREFORE

(57) Abstract: A synthetic polypeptide is disclosed, which comprises a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide. Synthetic polynucleotides are also disclosed that code for the synthetic polypeptides of the invention as well as expression constructs comprising the synthetic polynucleotides. Also disclosed are methods for constructing the aforementioned molecules and immunopotentiating compositions and methods for treating and/or preventing a disease or condition.

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SYNTHETIC PEPTIDES AND USES THEREFORE

FIELD OF THE INVENTION

THIS INVENTION relates generally to agents for modulating immune responses. More particularly, the present invention relates to a synthetic polypeptide comprising a plurality of different segments of a parent polypeptide, wherein the segments are linked to each other such that one or more functions of the parent polypeptide are impeded, abrogated or otherwise altered and such that the synthetic polypeptide, when introduced into a suitable host, can elicit an immune response against the parent polypeptide. The invention also relates to synthetic polynucleotides encoding the synthetic polypeptides and to synthetic constructs comprising these polynucleotides. The invention further relates to the use of the polypeptides and polynucleotides of the invention in compositions for modulating immune responses. The invention also extends to methods of using such compositions for prophylactic and/or therapeutic purposes.

Bibliographic details of various publications referred to in this specification are collected at the end of the description.

BACKGROUND OF THE INVENTION

The modern reductionist approach to vaccine and therapy development has been pursued for a number of decades and attempts to focus only on those parts of pathogens or of cancer proteins which are relevant to the immune system. To date the performance of this approach has been relatively poor considering the vigorous research carried out and the number of effective vaccines and therapies that it has produced. This approach is still being actively pursued, however, despite its poor performance because vaccines developed using this approach are often extremely safe and because only by completely understanding the immune system can new vaccine strategies be developed.

One area that has benefited greatly from research efforts is knowledge about how the adaptive immune system operates and more specifically how T and B cells learn to recognise specific parts of pathogens and cancers. T cells are mainly involved in cell-mediated immunity whereas B cells are involved in the generation of antibody-mediated immunity. The two most important types of T cells involved in adaptive cellular immunity

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are $\alpha\beta$ CD8⁺ cytotoxic T lymphocytes (CTL) and CD4⁺ T helper lymphocytes. CTL are important mediators of cellular immunity against many viruses, tumours, some bacteria and some parasites because they are able to kill infected cells directly and secrete various factors which can have powerful effects on the spread of infectious organisms. CTLs
5 recognise epitopes derived from foreign intracellular proteins, which are 8-10 amino acids long and which are presented by class I major histocompatibility complex (MHC) molecules (in humans called human lymphocyte antigens - HLAs) (Jardetzky *et al.*, 1991; Fremont *et al.*, 1992; Rotzschke *et al.*, 1990). T helper cells enhance and regulate CTL responses and are necessary for the establishment of long-lived memory CTL. They also
10 inhibit infectious organisms by secreting cytokines such as IFN- γ . T helper cells recognise epitopes derived mostly from extracellular proteins which are 12-25 amino acids long and which are presented by class II MHC molecules (Chicz *et al.*, 1993; Newcomb *et al.*, 1993). B cells, or more specifically the antibodies they secrete, are important mediators in the control and clearance of mostly extracellular organisms. Antibodies recognise mainly
15 conformational determinants on the surface of organisms, for example, although sometimes they may recognise short linear determinants.

Despite significant advances towards understanding how T and linear B cell epitopes are processed and presented to the immune system, the full potential of epitope-based vaccines has not been fully exploited. The main reason for this is the large number
20 of different T cell epitopes, which have to be included into such vaccines to cover the extreme HLA polymorphism in the human population. The human HLA diversity is one of the main reasons why whole pathogen vaccines frequently provide better population coverage than subunit or peptide-based vaccine strategies. There is a range of epitope-based strategies though which have tried to solve this problem, *e.g.*, peptide blends, peptide
25 conjugates and polypeptide vaccines (ie comprising strings of multiple epitopes) (Dyall *et al.*, 1995; Thomson *et al.*, 1996; Thomson *et al.*, 1998; Thomson *et al.*, 1998). These approaches however will always be sub optimal not only because of the slow pace of epitope characterisation but also, because it is virtually impossible for them to cover every existing HLA polymorphism in the population. A number of strategies have sought to
30 avoid both problems by not identifying epitopes and instead incorporating larger amounts of sequence information *e.g.*, approaches using whole genes or proteins and approaches that mix multiple protein or gene sequences together. The proteins used by these strategies

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however sometimes still function and therefore can compromise vaccine safety *e.g.*, whole cancer proteins. Alternative strategies have tried to improve the safety of vaccines by fragmenting the genes and expressing them either separately or as complex mixtures *e.g.*, library DNA immunisation or by ligating such fragments back together. These approaches
5 are still sub-optimal because they are too complex, generate poor levels of immunity, cannot guarantee that all proteins no longer function and/or that all fragments are present, which compromises substantially complete immunological coverage.

The lack of a safe and efficient vaccine strategy that can provide substantially complete immunological coverage is an important problem, especially when trying to
10 develop vaccines against rapidly mutating and persistent viruses such as HIV and hepatitis C virus, because partial population coverage could allow vaccine-resistant pathogens to re-emerge in the future. Human immunodeficiency virus (HIV) is an RNA lentivirus virus approximately 9 kb in length, which infects CD4⁺ T cells, causing T cell decline and AIDS typically 3-8 years after infection. It is currently the most serious human viral infection,
15 evidenced by the number of people currently infected with HIV or who have died from AIDS, estimated by the World Health Organisation (WHO) and UNAIDS in their AIDS epidemic update (December 1999) to be 33.6 and 16.3 million people, respectively. The spread of HIV is also now increasing fastest in areas of the world where over half of the human population reside, hence an effective vaccine is desperately needed to curb the
20 spread of this epidemic. Despite the urgency, an effective vaccine for HIV is still some way off because of delays in defining the correlates of immune protection, lack of a suitable animal model, existence of up to 8 different subtypes of HIV and a high HIV mutation rate.

A significant amount of research has been carried out to try and develop a vaccine
25 capable of generating neutralising antibody responses that can protect against field isolates of HIV. Despite these efforts, it is now clear that the variability, instability and inaccessibility of critical determinants on the HIV envelope protein will make it extremely difficult and perhaps impossible to develop such a vaccine (Kwong *et al.*, 1998). The limited ability of antibodies to block HIV infection is also supported by the observation
30 that development of AIDS correlates primarily with a reduction in CTL responsiveness to HIV and not to altered antibody levels (Ogg *et al.*, 1998). Hence CTL-mediated and not antibody-mediated responses appear to be critical for maintaining the asymptomatic state

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in vivo. There is also some evidence to suggest that pre-existing HIV-specific CTL responses can block the establishment of a latent HIV infection. This evidence comes from a number of cases where individuals have generated HIV-specific CTL responses without becoming infected and appear to be protected from establishing latent HIV infections
5 despite repeated virus exposure (Rowland-Jones *et al.*, 1995; Parmiani 1998). Taken together, these observations suggest that a vaccine capable of generating a broad range of strong CTL responses may be able to stop individuals from becoming latently infected with HIV or at least allow infected individuals to remain asymptomatic for life. Virtually all of the candidate HIV vaccines developed to date have been derived from subtype B
10 HIV proteins (western world subtype) whereas the majority of the HIV infections worldwide are caused by subtypes A/E or C (E and A are similar except in the envelop protein)(referred to as developing world subtypes). Hence existing candidate vaccines may not be suitable for the more common HIV subtypes. Recently, there has been some evidence that B subtype vaccines may be partially effective against other common HIV
15 subtypes (Rowland-Jones *et al.*, 1998). Accordingly, the desirability of a vaccine still remains, whose effectiveness is substantially complete against all isolates of all strains of HIV.

SUMMARY OF THE INVENTION

The present invention is predicated in part on a novel strategy for enhancing the efficacy of an immunopotentiating composition. This strategy involves utilising the sequence information of a parent polypeptide to produce a synthetic polypeptide that
5 comprises a plurality of different segments of the parent polypeptide, which are linked sequentially together in a different arrangement relative to that of the parent polypeptide. As a result of this change in relationship, the sequence of the linked segments in the synthetic polypeptide is different to a sequence contained within the parent polypeptide. As more fully described hereinafter, the present strategy is used advantageously to cause
10 significant disruption to the structure and/or function of the parent polypeptide while minimising the destruction of potentially useful epitopes encoded by the parent polypeptide.

Thus, in one aspect of the present invention, there is provided a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide,
15 wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide.

In one embodiment, the synthetic polypeptide consists essentially of different segments of a single parent polypeptide.

In an alternate embodiment, the synthetic polypeptide consists essentially of
20 different segments of a plurality of different parent polypeptides.

Suitably, said segments in said synthetic polypeptide are linked sequentially in a different order or arrangement relative to that of corresponding segments in said at least one parent polypeptide.

Preferably, at least one of said segments comprises partial sequence identity or
25 homology to one or more other said segments. The sequence identity or homology is preferably contained at one or both ends of said at least one segment.

In another aspect, the invention resides in a synthetic polynucleotide encoding the synthetic polypeptide as broadly described above.

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According to yet another aspect, the invention contemplates a synthetic construct comprising a said polynucleotide as broadly described above that is operably linked to a regulatory polynucleotide.

In a further aspect of the invention, there is provided a method for producing a
5 synthetic polynucleotide as broadly described above, comprising:

- linking together in the same reading frame a plurality of nucleic acid sequences encoding different segments of at least one parent polypeptide to form a synthetic polynucleotide whose sequence encodes said segments linked together in a different relationship relative to their linkage in the at least one parent polypeptide.

10 Preferably, the method further comprises fragmenting the sequence of a respective parent polypeptide into fragments and linking said fragments together in a different relationship relative to their linkage in said parent polypeptide sequence. In a preferred embodiment of this type, the fragments are randomly linked together.

Suitably, the method further comprises reverse translating the sequence of a
15 respective parent polypeptide or a segment thereof to provide a nucleic acid sequence encoding said parent polypeptide or said segment. In a preferred embodiment of this type, an amino acid of said parent polypeptide sequence is reverse translated to provide a codon, which has higher translational efficiency than other synonymous codons in a cell of interest. Suitably, an amino acid of said parent polypeptide sequence is reverse translated
20 to provide a codon which, in the context of adjacent or local sequence elements, has a lower propensity of forming an undesirable sequence (e.g., a palindromic sequence or a duplicated sequence) that is refractory to the execution of a task (e.g., cloning or sequencing).

In another aspect, the invention encompasses a computer program product for
25 designing the sequence of a synthetic polypeptide as broadly described above, comprising:

- code that receives as input the sequence of at least one parent polypeptide;
- code that fragments the sequence of a respective parent polypeptide into fragments;

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- code that links together said fragments in a different relationship relative to their linkage in said parent polypeptide sequence; and
- a computer readable medium that stores the codes.

In yet another aspect, the invention provides a computer program product for
5 designing the sequence of a synthetic polynucleotide as broadly described above, comprising:

- code that receives as input the sequence of at least one parent polypeptide;
- code that fragments the sequence of a respective parent polypeptide into fragments;
- 10 - code that reverse translates the sequence of a respective fragment to provide a nucleic acid sequence encoding said fragment;
- code that links together in the same reading frame each said nucleic acid sequence to provide a polynucleotide sequence that codes for a polypeptide sequence in which said fragments are linked together in a different relationship relative to their
15 linkage in the at least one parent polypeptide sequence; and
- a computer readable medium that stores the codes.

In still yet another aspect, the invention provides a computer for designing the sequence of a synthetic polypeptide as broadly described above, wherein said computer comprises:

- 20 (a) a machine-readable data storage medium comprising a data storage material encoded with machine-readable data, wherein said machine-readable data comprise the sequence of at least one parent polypeptide;
- (b) a working memory for storing instructions for processing said machine-readable data;
- 25 (c) a central-processing unit coupled to said working memory and to said machine-readable data storage medium, for processing said machine readable data to provide said synthetic polypeptide sequence; and
- (d) an output hardware coupled to said central processing unit, for receiving said synthetic polypeptide sequence.

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In a preferred embodiment, the processing of said machine readable data comprises fragmenting the sequence of a respective parent polypeptide into fragments and linking together said fragments in a different relationship relative to their linkage in the sequence of said parent polypeptide.

5 In still yet another aspect, the invention resides in a computer for designing the sequence of a synthetic polynucleotide as broadly described above, wherein said computer comprises:

(a) a machine-readable data storage medium comprising a data storage material encoded with machine-readable data, wherein said machine-readable data comprise the
10 sequence of at least one parent polypeptide;

(b) a working memory for storing instructions for processing said machine-readable data;

(c) a central-processing unit coupled to said working memory and to said machine-readable data storage medium, for processing said machine readable data to provide said
15 synthetic polynucleotide sequence; and

(d) an output hardware coupled to said central processing unit, for receiving said synthetic polynucleotide sequence.

In a preferred embodiment, the processing of said machine readable data comprises fragmenting the sequence of a respective parent polypeptide into fragments,
20 reverse translating the sequence of a respective fragment to provide a nucleic acid sequence encoding said fragment and linking together in the same reading frame each said nucleic acid sequence to provide a polynucleotide sequence that codes for a polypeptide sequence in which said fragments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide sequence.

25 According to another aspect, the invention contemplates a composition, comprising an immunopotentiating agent selected from the group consisting of a synthetic polypeptide as broadly described above, a synthetic polynucleotide as broadly described above and a synthetic construct as broadly described above, together with a pharmaceutically acceptable carrier.

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The composition may optionally comprise an adjuvant.

In a further aspect, the invention encompasses a method for modulating an immune response, which response is preferably directed against a pathogen or a cancer, comprising administering to a patient in need of such treatment an effective amount of an immunopotentiating agent selected from the group consisting of a synthetic polypeptide as broadly described above, a synthetic polynucleotide as broadly described above and a synthetic construct as broadly described above, or a composition as broadly described above.

According to still a further aspect of the invention, there is provided a method for treatment and/or prophylaxis of a disease or condition, comprising administering to a patient in need of such treatment an effective amount of an immunopotentiating agent selected from the group consisting of a synthetic polypeptide as broadly described above, a synthetic polynucleotide as broadly described above and a synthetic construct as broadly described above, or a composition as broadly described above.

The invention also encompasses the use of the synthetic polypeptide, the synthetic polynucleotide and the synthetic construct as broadly described above in the study, and modulation of immune responses.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagrammatic representation showing the number of people living with AIDS in 1998 in various parts of the world and most prevalent HIV clades in these regions. Estimates generated by UNAIDS.

- 5 Figure 2 is a graphical representation showing trends in the incidence of the common HIV clades and estimates for the future. Graph from the International Aids Vaccine Initiative (IAVI).

- Figure 3 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV gag [SEQ ID NO: 1] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade
10 consensus sequences for the HIV gag protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR 98-485.

- 15 Figure 4 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV pol [SEQ ID NO: 2] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade consensus sequences for the HIV pol protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton
20 Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR98-485.

- Figure 5 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV vif [SEQ ID NO: 3] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade
25 consensus sequences for the HIV vif protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR98-485.

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Figure 6 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV vpr [SEQ ID NO: 4] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade consensus sequences for the HIV vpr protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR 98-485.

Figure 7 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV tat [SEQ ID NO: 5] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade consensus sequences for the HIV tat protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR 98-485.

Figure 8 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV rev [SEQ ID NO: 6] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade consensus sequences for the HIV rev protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR 98-485.

Figure 9 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV vpu [SEQ ID NO: 7] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade consensus sequences for the HIV vpu protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR 98-485.

Figure 10 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV env [SEQ ID NO: 8] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade

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consensus sequences for the HIV env protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR 98-485.

- 5 Figure 11 is a diagrammatic representation showing overlapping segments of a parent polypeptide sequence for HIV nef [SEQ ID NO: 9] used for the construction of an embodiment of an HIV Savine. Also shown are the alignments of common HIV clade consensus sequences for the HIV nef protein from the HIV Molecular Immunology Database 1997, Editors Bette Korber, John Moore, Cristian Brander, Richard Koup, Barton
10 Haynes and Bruce Walker. Publisher, Los Alamos National Laboratory, Theoretical Biology and Biophysics, Los Alamos, New Mexico, Pub LAUR 98-485.

Figure 12 is a diagrammatic representation depicting the systematic segmentation of the designed degenerate consensus sequences for each HIV protein and the reverse translation of each segment into a DNA sequence. Also shown is the number of segments
15 used during random rearrangement and amino acids that were removed. Amino acids surrounded by an open square were removed from the design, because degenerate codons to cater for the desired amino acid combination required too many degenerate bases to comply with the incorporation of degenerate sequence rules outlined in the description of the invention herein. Amino acids surrounded by an open circle were removed only in the
20 segment concerned mainly because they were coded for in an oligonucleotide overlap region. Amino acids marked with an asterisk were designed differently in one fragment compared to the corresponding overlap region (see tat gene)

Figure 13 is a diagrammatic representation showing the first and second most frequently used codons in mammals used to reverse translate HIV protein segments. Also
25 shown are all first and second most frequently used degenerate codons for two amino acids where only one base is varied. Codons used where more than one base was varied were worked out in each case by comparing all the codons for each amino acid. The IUPAC codes for degenerate bases are also shown.

Figure 14 illustrates the construction plan for the HIV Savine showing the
30 approximate sizes of the subcassettes, cassettes and full-length Savine cDNA and the restriction sites involved in joining them together. Also shown are the extra sequences

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added onto each subcassette during their design and a brief description of how the subcassettes, cassettes and full length cDNA were constructed and transferred into appropriate DNA plasmids. *Description of full length construction:* pA was cleaved with *XhoI/SaII* and cloned into *XhoI* arms of the B cassette; pAB was cleaved with *XhoI* and
 5 cloned into *XhoI* arms of the C cassette; full length construct is excisable with either *XbaI/BamHI* at the 5' end or *BglII* at the 3' end. *Options for excising cassettes:* A) *XbaI/BamHI* at the 5' end, *BglII/XhoI* at the 3' end; B) *XbaI/BamHI* at the 5' end, *BglII/SaII* at the 3' end; C) *XbaI/BamHI* at the 5' end, *BglII/SaII* at the 3' end. *Cleaving plasmid vectors:* pDNAVacc is cleavable with *XbaI/XhoI* (DNA vaccination); pBCB07 or
 10 pTK7.5 vectors are cleavable with *BamHI/SaII* (Recombinant Vaccinia); pAvipox vector pAF09 is cleavable with *BamHI/SaII* (Recombinant Avipox).

Figure 15 shows the full length DNA (17253 bp) and protein sequence (5742 aas) of the HIV Savine construct. Fragment boundaries are shown, together with the position of each fragment in each designed HIV protein, fragment number (in brackets), spacer
 15 residues (two alanine residues) and which fragment the spacer was for (open boxes and arrows). The location of residual restriction site joining sequences corresponding to subcassette or cassette boundaries (shaded boxes) are also shown, along with start and stop codons, Kozak sequence, the location of the murine influenza virus CTL epitope sequence (near the 3' end), important restriction sites at each end and the position of each degenerate
 20 amino acid (indicated by 'X').

Figure 16 depicts the layout and position of oligonucleotides in the designed DNA sequence for subcassette A1. The sequences which anneal to the short amplification oligonucleotides are indicated by hatched boxes and the position of oligonucleotide overlap regions are dark shaded.

25 Figure 17: Panel (a) depicts the stepwise asymmetric PCR of the two halves of subcassette A1 (lanes 2-5 and 7-9, respectively) and final splicing together by SOEing (lane 10). DNA standards in lane 1 are pUC18 digested with *Sau3AI*. Panel (b) shows the stepwise ligation-mediated joining and PCR amplification of each cassette as indicated. DNA standards in lane 1 are SPP1 cut with *EcoRI*.

30 Figure 18: Panel (a) shows summary of the construction of the DNA vaccine plasmids that express one HIV Savine cassette. Panel (b) shows a summary of the

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construction of the plasmids used for marker rescue recombination to generate Vaccinia viruses expressing one HIV Savine cassette. Panel (c) shows a summary of the construction of the DNA vaccine plasmids which each express a version of the full-length HIV Savine cDNA

5 Figure 19 shows restimulation of HIV specific polyclonal CTL responses from three HIV-infected patients by the HIV Savine constructs. PBMCs from three different patients were restimulated for 7 days by infection with Vaccinia virus pools expressing the HIV Savine cassettes: Pool 1 included VV-AC1 and VV-BC1; Pool 2 included VV-AC2, VV-BC2 and VV-CC2. The restimulated PBMCs were then mixed with autologous LCLs
10 (effector to target ratio of 50:1), which were either uninfected or infected with either Vaccinia viruses expressing the HIV proteins gag (VV-gag), env (VV-env) or pol (VV-pol), VV- HIV Savine pools 1 (light bars) or 2 (dark bars) or a control Vaccinia virus (VV-Lac) and the amount of ^{51}Cr released used to determine percent specific lysis. K562 cells were used to determine the level of NK cell-mediated killing in their stimulated culture.

15 Figure 20 is a diagrammatic representation showing CD4+ proliferation of PBMCs from HIV-1 infected patients restimulated with either Pool1 or Pool2 of the HIV-1 Savine. Briefly PBMCs were stained with CFSE and culture for 6 days with or without VVs encoding either pool1 or pool2 of the HIV-1 Savine. Restimulated Cells were then labelled with antibodies and analysed by FACS.

20 Figure 21 is a graphical representation showing the CTL response in mice vaccinated with the HIV Savine. C57BL6 mice were immunised with the HIV-1 Savine DNA vaccine comprising the six plasmids described in Figure 18a (100 μg total DNA was given as 50 $\mu\text{g}/\text{leg}$ i.m.). One week later Poxviruses (1×10^7 pfu) comprising Pool 1 of the HIV-1 Savine were used to boost the immune responses. Three weeks later splenocytes
25 from these mice were restimulated with VV-Pool 1 or VV-Pool 2 for 5 days and the resultant effectors used in a ^{51}Cr release cytotoxicity assay against targets infected with CTRVV, VV-pools or VV expressing the natural antigens from HIV-1.

Figure 22 shows immune responses of HIV Immune Macaques (vaccinated with recombinant FPV expressing gag-pol and challenged with HIV-1 2 years prior to
30 experiment). Monkeys 1 and 2 were immunised once at day 0 with VV Savine pool 1 (Three VVs which together express the entire HIV Savine). Monkey 3 was immunised

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twice with FPV-gag-pol *i.e.*, Day 0 is 3 weeks after first FPV-gag-pol immunisation. A) IFN- γ detection by ELISPOT of whole blood (0.5 mL, venous blood heparin-anticoagulated) stimulated with Aldrithiol-2 inactivated whole HIV-1 (20 hours, 20 μ g/mL). Plasma samples were then centrifuged (1000xg) and assayed in duplicate for antigen-specific IFN using capture ELISA. B) Flow cytometric detection of HIV-1 specific CD69+/CD8+ T cells. Freshly isolated PBMCs were stimulated with inactivated HIV-1 as above for 16 hours, washed and labelled with the antibodies. Cells were then analysed using a FACScalibur™ flow cytometer and data. analysed using Cell-Quest software. C) Flow cytometric detection of HIV-1 specific CD69+/CD4+ T cells carried out as in B).

10 Figure 23 shows a diagram of a system used to carry out the instructions encoded by the storage medium of Figures 28 and 29.

Figure 24 depicts a flow diagram showing an embodiment of a method for designing synthetic polynucleotide and synthetic polypeptides of the invention.

15 Figure 25 shows an algorithm, which *inter alia* utilises the steps of the method shown in Figure 24.

Figure 26 shows an example of applying the algorithm of Figure 25 to an input consensus polyprotein sequence of Hepatitis C 1a to execute the segmentation of the polyprotein sequence, the rearrangement of the segments, the linkage of the rearranged segments and the outputting of synthetic polynucleotide and polypeptide sequences for the preparation of Savines for treating and/or preventing Hepatitis C infection.

20 Figure 27 illustrates an example of applying the algorithm of Figure 25 to input consensus melanocyte differentiation antigens (gp100, MART, TRP-1, Tyros, Trp-2, MC1R, MUC1F and MUC1R) and to consensus melanoma specific antigens (BAGE, GAGE-1, gp100In4, MAGE-1, MAGE-3, PRAME, TRP2IN2, NYNSO1a, NYNSO1b and LAGE1) to facilitate segmentation of those sequences, to rearrange the segments, to link the rearranged segments and to synthetic polynucleotide and polypeptide sequences for the preparation of Savines for treating and/or preventing melanoma.

Figure 28 shows a cross section of a magnetic storage medium.

Figure 29 shows a cross section of an optically readable data storage medium.

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Figure 30 shows six HIV Savine cassette sequences (A1 [SEQ ID NO: 393], A2 [SEQ ID NO: 399], B1[SEQ ID NO: 395], B2 [SEQ ID NO: 401], C1 [SEQ ID NO: 397] and C2 [SEQ ID NO: 403]). A1, B1 and C1 can be joined together using, for example, convenient restriction enzyme sites provided at the ends of each cassette to construct an
5 embodiment of a full length HIV Savine [SEQ ID NO: 405]. A2, B2 and C2 can also be joined together to provide another embodiment of a full length HIV Savine with 350 aa mutations common in major HIV clades. The cassettes A/B/C can be joined into single constructs using specific restriction enzyme sites incorporated after the start codon or before the stop codon in the cassettes

BRIEF DESCRIPTION OF THE SEQUENCES: SUMMARY TABLE**TABLE A**

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 1	GAG consensus polypeptide	499 aa
SEQ ID NO: 2	POL consensus polypeptide	995 aa
SEQ ID NO: 3	VIF consensus polypeptide	192 aa
SEQ ID NO: 4	VPR consensus polypeptide	96 aa
SEQ ID NO: 5	TAT consensus polypeptide	102 aa
SEQ ID NO: 6	REV consensus polypeptide	123 aa
SEQ ID NO: 7	VPU consensus polypeptide	81 aa
SEQ ID NO: 8	ENV consensus polypeptide	651 aa
SEQ ID NO: 9	NEF consensus polypeptide	206 aa
SEQ ID NO: 10	GAG segment 1	90 nts
SEQ ID NO: 11	Polypeptide encoded by SEQ ID NO: 10	30 aa
SEQ ID NO: 12	GAG segment 2	90 nts
SEQ ID NO: 13	Polypeptide encoded by SEQ ID NO: 12	30 aa
SEQ ID NO: 14	GAG segment 3	90 nts
SEQ ID NO: 15	Polypeptide encoded by SEQ ID NO: 14	30 aa
SEQ ID NO: 16	GAG segment 4	90 nts
SEQ ID NO: 17	Polypeptide encoded by SEQ ID NO: 16	30 aa
SEQ ID NO: 18	GAG segment 5	90 nts
SEQ ID NO: 19	Polypeptide encoded by SEQ ID NO: 18	30 aa
SEQ ID NO: 20	GAG segment 6	90 nts
SEQ ID NO: 21	Polypeptide encoded by SEQ ID NO: 20	30 aa
SEQ ID NO: 22	GAG segment 7	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 23	Polypeptide encoded by SEQ ID NO: 22	30 aa
SEQ ID NO: 24	GAG segment 8	90 nts
SEQ ID NO: 25	Polypeptide encoded by SEQ ID NO: 24	30 aa
SEQ ID NO: 26	GAG segment 9	90 nts
SEQ ID NO: 27	Polypeptide encoded by SEQ ID NO: 26	30 aa
SEQ ID NO: 28	GAG segment 10	90 nts
SEQ ID NO: 29	Polypeptide encoded by SEQ ID NO: 28	30 aa
SEQ ID NO: 30	GAG segment 11	90 nts
SEQ ID NO: 31	Polypeptide encoded by SEQ ID NO: 30	30 aa
SEQ ID NO: 32	GAG segment 12	90 nts
SEQ ID NO: 33	Polypeptide encoded by SEQ ID NO: 32	30 aa
SEQ ID NO: 34	GAG segment 13	90 nts
SEQ ID NO: 35	Polypeptide encoded by SEQ ID NO: 34	30 aa
SEQ ID NO: 36	GAG segment 14	90 nts
SEQ ID NO: 37	Polypeptide encoded by SEQ ID NO: 36	30 aa
SEQ ID NO: 38	GAG segment 15	90 nts
SEQ ID NO: 39	Polypeptide encoded by SEQ ID NO: 38	30 aa
SEQ ID NO: 40	GAG segment 16	90 nts
SEQ ID NO: 41	Polypeptide encoded by SEQ ID NO: 40	30 aa
SEQ ID NO: 42	GAG segment 17	90 nts
SEQ ID NO: 43	Polypeptide encoded by SEQ ID NO: 42	30 aa
SEQ ID NO: 44	GAG segment 18	90 nts
SEQ ID NO: 45	Polypeptide encoded by SEQ ID NO: 44	30 aa
SEQ ID NO: 46	GAG segment 19	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 47	Polypeptide encoded by SEQ ID NO: 46	30 aa
SEQ ID NO: 48	GAG segment 20	90 nts
SEQ ID NO: 49	Polypeptide encoded by SEQ ID NO: 48	30 aa
SEQ ID NO: 50	GAG segment 21	90 nts
SEQ ID NO: 51	Polypeptide encoded by SEQ ID NO: 50	30 aa
SEQ ID NO: 52	GAG segment 22	90 nts
SEQ ID NO: 53	Polypeptide encoded by SEQ ID NO: 52	30 aa
SEQ ID NO: 54	GAG segment 23	90 nts
SEQ ID NO: 55	Polypeptide encoded by SEQ ID NO: 54	30 aa
SEQ ID NO: 56	GAG segment 24	90 nts
SEQ ID NO: 57	Polypeptide encoded by SEQ ID NO: 56	30 aa
SEQ ID NO: 58	GAG segment 25	90 nts
SEQ ID NO: 59	Polypeptide encoded by SEQ ID NO: 58	30 aa
SEQ ID NO: 60	GAG segment 26	90 nts
SEQ ID NO: 61	Polypeptide encoded by SEQ ID NO: 60	30 aa
SEQ ID NO: 62	GAG segment 27	90 nts
SEQ ID NO: 63	Polypeptide encoded by SEQ ID NO: 62	30 aa
SEQ ID NO: 64	GAG segment 28	90 nts
SEQ ID NO: 65	Polypeptide encoded by SEQ ID NO: 64	30 aa
SEQ ID NO: 66	GAG segment 29	90 nts
SEQ ID NO: 67	Polypeptide encoded by SEQ ID NO: 66	30 aa
SEQ ID NO: 68	GAG segment 30	90 nts
SEQ ID NO: 69	Polypeptide encoded by SEQ ID NO: 68	30 aa
SEQ ID NO: 70	GAG segment 31	90 nts

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SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 71	Polypeptide encoded by SEQ ID NO: 70	30 aa
SEQ ID NO: 72	GAG segment 32	90 nts
SEQ ID NO: 73	Polypeptide encoded by SEQ ID NO: 72	30 aa
SEQ ID NO: 74	GAG segment 33	57 nts
SEQ ID NO: 75	Polypeptide encoded by SEQ ID NO: 74	19 aa
SEQ ID NO: 76	POL segment 1	90 nts
SEQ ID NO: 77	Polypeptide encoded by SEQ ID NO: 76	30 aa
SEQ ID NO: 78	POL segment 2	90 nts
SEQ ID NO: 79	Polypeptide encoded by SEQ ID NO: 78	30 aa
SEQ ID NO: 80	POL segment 3	90 nts
SEQ ID NO: 81	Polypeptide encoded by SEQ ID NO: 80	30 aa
SEQ ID NO: 82	POL segment 4	90 nts
SEQ ID NO: 83	Polypeptide encoded by SEQ ID NO: 82	30 aa
SEQ ID NO: 84	POL segment 5	90 nts
SEQ ID NO: 85	Polypeptide encoded by SEQ ID NO: 84	30 aa
SEQ ID NO: 86	POL segment 6	90 nts
SEQ ID NO: 87	Polypeptide encoded by SEQ ID NO: 86	30 aa
SEQ ID NO: 88	POL segment 7	90 nts
SEQ ID NO: 89	Polypeptide encoded by SEQ ID NO: 88	30 aa
SEQ ID NO: 90	POL segment 8	90 nts
SEQ ID NO: 91	Polypeptide encoded by SEQ ID NO: 90	30 aa
SEQ ID NO: 92	POL segment 9	90 nts
SEQ ID NO: 93	Polypeptide encoded by SEQ ID NO: 92	30 aa
SEQ ID NO: 94	POL segment 10	90 nts

SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 95	Polypeptide encoded by SEQ ID NO: 94	30 aa
SEQ ID NO: 96	POL segment 11	90 nts
SEQ ID NO: 97	Polypeptide encoded by SEQ ID NO: 96	30 aa
SEQ ID NO: 98	POL segment 12	90 nts
SEQ ID NO: 99	Polypeptide encoded by SEQ ID NO: 98	30 aa
SEQ ID NO: 100	POL segment 13	90 nts
SEQ ID NO: 101	Polypeptide encoded by SEQ ID NO: 100	30 aa
SEQ ID NO: 102	POL segment 14	90 nts
SEQ ID NO: 103	Polypeptide encoded by SEQ ID NO: 102	30 aa
SEQ ID NO: 104	POL segment 15	90 nts
SEQ ID NO: 105	Polypeptide encoded by SEQ ID NO: 104	30 aa
SEQ ID NO: 106	POL segment 16	90 nts
SEQ ID NO: 107	Polypeptide encoded by SEQ ID NO: 106	30 aa
SEQ ID NO: 108	POL segment 17	90 nts
SEQ ID NO: 109	Polypeptide encoded by SEQ ID NO: 108	30 aa
SEQ ID NO: 110	POL segment 18	90 nts
SEQ ID NO: 111	Polypeptide encoded by SEQ ID NO: 110	30 aa
SEQ ID NO: 112	POL segment 19	90 nts
SEQ ID NO: 113	Polypeptide encoded by SEQ ID NO: 112	30 aa
SEQ ID NO: 114	POL segment 20	90 nts
SEQ ID NO: 115	Polypeptide encoded by SEQ ID NO: 114	30 aa
SEQ ID NO: 116	POL segment 21	90 nts
SEQ ID NO: 117	Polypeptide encoded by SEQ ID NO: 116	30 aa
SEQ ID NO: 118	POL segment 22	90 nts

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 119	Polypeptide encoded by SEQ ID NO: 118	30 aa
SEQ ID NO: 120	POL segment 23	90 nts
SEQ ID NO: 121	Polypeptide encoded by SEQ ID NO: 120	30 aa
SEQ ID NO: 122	POL segment 24	90 nts
SEQ ID NO: 123	Polypeptide encoded by SEQ ID NO: 122	30 aa
SEQ ID NO: 124	POL segment 25	90 nts
SEQ ID NO: 125	Polypeptide encoded by SEQ ID NO: 124	30 aa
SEQ ID NO: 126	POL segment 26	90 nts
SEQ ID NO: 127	Polypeptide encoded by SEQ ID NO: 126	30 aa
SEQ ID NO: 128	POL segment 27	90 nts
SEQ ID NO: 129	Polypeptide encoded by SEQ ID NO: 128	30 aa
SEQ ID NO: 130	POL segment 28	90 nts
SEQ ID NO: 131	Polypeptide encoded by SEQ ID NO: 130	30 aa
SEQ ID NO: 132	POL segment 29	90 nts
SEQ ID NO: 133	Polypeptide encoded by SEQ ID NO: 132	30 aa
SEQ ID NO: 134	POL segment 30	90 nts
SEQ ID NO: 135	Polypeptide encoded by SEQ ID NO: 134	30 aa
SEQ ID NO: 136	POL segment 31	90 nts
SEQ ID NO: 137	Polypeptide encoded by SEQ ID NO: 136	30 aa
SEQ ID NO: 138	POL segment 32	90 nts
SEQ ID NO: 139	Polypeptide encoded by SEQ ID NO: 138	30 aa
SEQ ID NO: 140	POL segment 33	90 nts
SEQ ID NO: 141	Polypeptide encoded by SEQ ID NO: 140	30 aa
SEQ ID NO: 142	POL segment 34	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 143	Polypeptide encoded by SEQ ID NO: 142	30 aa
SEQ ID NO: 144	POL segment 35	90 nts
SEQ ID NO: 145	Polypeptide encoded by SEQ ID NO: 144	30 aa
SEQ ID NO: 146	POL segment 36	90 nts
SEQ ID NO: 147	Polypeptide encoded by SEQ ID NO: 146	30 aa
SEQ ID NO: 148	POL segment 37	90 nts
SEQ ID NO: 149	Polypeptide encoded by SEQ ID NO: 148	30 aa
SEQ ID NO: 150	POL segment 38	90 nts
SEQ ID NO: 151	Polypeptide encoded by SEQ ID NO: 150	30 aa
SEQ ID NO: 152	POL segment 39	90 nts
SEQ ID NO: 153	Polypeptide encoded by SEQ ID NO: 152	30 aa
SEQ ID NO: 154	POL segment 40	90 nts
SEQ ID NO: 155	Polypeptide encoded by SEQ ID NO: 154	30 aa
SEQ ID NO: 156	POL segment 41	90 nts
SEQ ID NO: 157	Polypeptide encoded by SEQ ID NO: 156	30 aa
SEQ ID NO: 158	POL segment 42	90 nts
SEQ ID NO: 159	Polypeptide encoded by SEQ ID NO: 158	30 aa
SEQ ID NO: 160	POL segment 43	90 nts
SEQ ID NO: 161	Polypeptide encoded by SEQ ID NO: 160	30 aa
SEQ ID NO: 162	POL segment 44	90 nts
SEQ ID NO: 163	Polypeptide encoded by SEQ ID NO: 162	30 aa
SEQ ID NO: 164	POL segment 45	90 nts
SEQ ID NO: 165	Polypeptide encoded by SEQ ID NO: 164	30 aa
SEQ ID NO: 166	POL segment 46	90 nts

SEQ ID NO NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 167	Polypeptide encoded by SEQ ID NO: 166	30 aa
SEQ ID NO: 168	POL segment 47	90 nts
SEQ ID NO: 169	Polypeptide encoded by SEQ ID NO: 168	30 aa
SEQ ID NO: 170	POL segment 48	90 nts
SEQ ID NO: 171	Polypeptide encoded by SEQ ID NO: 170	30 aa
SEQ ID NO: 172	POL segment 49	90 nts
SEQ ID NO: 173	Polypeptide encoded by SEQ ID NO: 172	30 aa
SEQ ID NO: 174	POL segment 50	90 nts
SEQ ID NO: 175	Polypeptide encoded by SEQ ID NO: 174	30 aa
SEQ ID NO: 176	POL segment 51	90 nts
SEQ ID NO: 177	Polypeptide encoded by SEQ ID NO: 176	30 aa
SEQ ID NO: 178	POL segment 52	90 nts
SEQ ID NO: 179	Polypeptide encoded by SEQ ID NO: 178	30 aa
SEQ ID NO: 180	POL segment 53	90 nts
SEQ ID NO: 181	Polypeptide encoded by SEQ ID NO: 180	30 aa
SEQ ID NO: 182	POL segment 54	90 nts
SEQ ID NO: 183	Polypeptide encoded by SEQ ID NO: 182	30 aa
SEQ ID NO: 184	POL segment 55	90 nts
SEQ ID NO: 185	Polypeptide encoded by SEQ ID NO: 184	30 aa
SEQ ID NO: 186	POL segment 56	90 nts
SEQ ID NO: 187	Polypeptide encoded by SEQ ID NO: 186	30 aa
SEQ ID NO: 188	POL segment 57	90 nts
SEQ ID NO: 189	Polypeptide encoded by SEQ ID NO: 188	30 aa
SEQ ID NO: 190	POL segment 58	90 nts

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 191	Polypeptide encoded by SEQ ID NO: 190	30 aa
SEQ ID NO: 192	POL segment 59	90 nts
SEQ ID NO: 193	Polypeptide encoded by SEQ ID NO: 192	30 aa
SEQ ID NO: 194	POL segment 60	90 nts
SEQ ID NO: 195	Polypeptide encoded by SEQ ID NO: 194	30 aa
SEQ ID NO: 196	POL segment 61	90 nts
SEQ ID NO: 197	Polypeptide encoded by SEQ ID NO: 196	30 aa
SEQ ID NO: 198	POL segment 62	90 nts
SEQ ID NO: 199	Polypeptide encoded by SEQ ID NO: 198	30 aa
SEQ ID NO: 200	POL segment 63	90 nts
SEQ ID NO: 201	Polypeptide encoded by SEQ ID NO: 200	30 aa
SEQ ID NO: 202	POL segment 64	90 nts
SEQ ID NO: 203	Polypeptide encoded by SEQ ID NO: 202	30 aa
SEQ ID NO: 204	POL segment 65	90 nts
SEQ ID NO: 205	Polypeptide encoded by SEQ ID NO: 204	30 aa
SEQ ID NO: 206	POL segment 66	60 nts
SEQ ID NO: 207	Polypeptide encoded by SEQ ID NO: 206	20 aa
SEQ ID NO: 208	VIF segment 1	90 nts
SEQ ID NO: 209	Polypeptide encoded by SEQ ID NO: 208	30 aa
SEQ ID NO: 210	VIF segment 2	90 nts
SEQ ID NO: 211	Polypeptide encoded by SEQ ID NO: 210	30 aa
SEQ ID NO: 212	VIF segment 3	90 nts
SEQ ID NO: 213	Polypeptide encoded by SEQ ID NO: 212	30 aa
SEQ ID NO: 214	VIF segment 4	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 215	Polypeptide encoded by SEQ ID NO: 214	30 aa
SEQ ID NO: 216	VIF segment 5	90 nts
SEQ ID NO: 217	Polypeptide encoded by SEQ ID NO: 216	30 aa
SEQ ID NO: 218	VIF segment 6	90 nts
SEQ ID NO: 219	Polypeptide encoded by SEQ ID NO: 218	30 aa
SEQ ID NO: 220	VIF segment 7	90 nts
SEQ ID NO: 221	Polypeptide encoded by SEQ ID NO: 220	30 aa
SEQ ID NO: 222	VIF segment 8	90 nts
SEQ ID NO: 223	Polypeptide encoded by SEQ ID NO: 222	30 aa
SEQ ID NO: 224	VIF segment 9	90 nts
SEQ ID NO: 225	Polypeptide encoded by SEQ ID NO: 224	30 aa
SEQ ID NO: 226	VIF segment 10	90 nts
SEQ ID NO: 227	Polypeptide encoded by SEQ ID NO: 226	30 aa
SEQ ID NO: 228	VIF segment 11	90 nts
SEQ ID NO: 229	Polypeptide encoded by SEQ ID NO: 228	30 aa
SEQ ID NO: 230	VIF segment 12	81 nts
SEQ ID NO: 231	Polypeptide encoded by SEQ ID NO: 230	27 aa
SEQ ID NO: 232	VPR segment 1	90 nts
SEQ ID NO: 233	Polypeptide encoded by SEQ ID NO: 232	30 aa
SEQ ID NO: 234	VPR segment 2	90 nts
SEQ ID NO: 235	Polypeptide encoded by SEQ ID NO: 234	30 aa
SEQ ID NO: 236	VPR segment 3	90 nts
SEQ ID NO: 237	Polypeptide encoded by SEQ ID NO: 236	30 aa
SEQ ID NO: 238	VPR segment 4	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 239	Polypeptide encoded by SEQ ID NO: 238	30 aa
SEQ ID NO: 240	VPR segment 5	90 nts
SEQ ID NO: 241	Polypeptide encoded by SEQ ID NO: 240	30 aa
SEQ ID NO: 242	VPR segment 6	63 nts
SEQ ID NO: 243	Polypeptide encoded by SEQ ID NO: 242	21 aa
SEQ ID NO: 244	TAT segment 1	90 nts
SEQ ID NO: 245	Polypeptide encoded by SEQ ID NO: 244	30 aa
SEQ ID NO: 246	TAT segment 2	90 nts
SEQ ID NO: 247	Polypeptide encoded by SEQ ID NO: 246	30 aa
SEQ ID NO: 248	TAT segment 3	90 nts
SEQ ID NO: 249	Polypeptide encoded by SEQ ID NO: 248	30 aa
SEQ ID NO: 250	TAT segment 4	90 nts
SEQ ID NO: 251	Polypeptide encoded by SEQ ID NO: 250	30 aa
SEQ ID NO: 252	TAT segment 5	90 nts
SEQ ID NO: 253	Polypeptide encoded by SEQ ID NO: 252	30 aa
SEQ ID NO: 254	TAT segment 6	81 nts
SEQ ID NO: 255	Polypeptide encoded by SEQ ID NO: 254	27 aa
SEQ ID NO: 256	REV segment 1	90 nts
SEQ ID NO: 257	Polypeptide encoded by SEQ ID NO: 256	30 aa
SEQ ID NO: 258	REV segment 2	90 nts
SEQ ID NO: 259	Polypeptide encoded by SEQ ID NO: 258	30 aa
SEQ ID NO: 260	REV segment 3	90 nts
SEQ ID NO: 261	Polypeptide encoded by SEQ ID NO: 260	30 aa
SEQ ID NO: 262	REV segment 4	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 263	Polypeptide encoded by SEQ ID NO: 262	30 aa
SEQ ID NO: 264	REV segment 5	90 nts
SEQ ID NO: 265	Polypeptide encoded by SEQ ID NO: 264	30 aa
SEQ ID NO: 266	REV segment 6	90 nts
SEQ ID NO: 267	Polypeptide encoded by SEQ ID NO: 266	30 aa
SEQ ID NO: 268	REV segment 7	90 nts
SEQ ID NO: 269	Polypeptide encoded by SEQ ID NO: 268	30 aa
SEQ ID NO: 270	REV segment 8	54 nts
SEQ ID NO: 271	Polypeptide encoded by SEQ ID NO: 270	18 aa
SEQ ID NO: 272	VPU segment 1	90 nts
SEQ ID NO: 273	Polypeptide encoded by SEQ ID NO: 272	30 aa
SEQ ID NO: 274	VPU segment 2	90 nts
SEQ ID NO: 275	Polypeptide encoded by SEQ ID NO: 274	30 aa
SEQ ID NO: 276	VPU segment 3	90 nts
SEQ ID NO: 277	Polypeptide encoded by SEQ ID NO: 276	30 aa
SEQ ID NO: 278	VPU segment 4	90 nts
SEQ ID NO: 279	Polypeptide encoded by SEQ ID NO: 278	30 aa
SEQ ID NO: 280	VPU segment 5	63 nts
SEQ ID NO: 281	Polypeptide encoded by SEQ ID NO: 280	21 aa
SEQ ID NO: 282	ENV segment 1	90 nts
SEQ ID NO: 283	Polypeptide encoded by SEQ ID NO: 282	30 aa
SEQ ID NO: 284	ENV segment 2	90 nts
SEQ ID NO: 285	Polypeptide encoded by SEQ ID NO: 284	30 aa
SEQ ID NO: 286	ENV segment 3	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 287	Polypeptide encoded by SEQ ID NO: 286	30 aa
SEQ ID NO: 288	ENV segment 4	90 nts
SEQ ID NO: 289	Polypeptide encoded by SEQ ID NO: 288	30 aa
SEQ ID NO: 290	ENV segment 5	90 nts
SEQ ID NO: 291	Polypeptide encoded by SEQ ID NO: 290	30 aa
SEQ ID NO: 292	ENV segment 6	90 nts
SEQ ID NO: 293	Polypeptide encoded by SEQ ID NO: 292	30 aa
SEQ ID NO: 294	ENV segment 7	90 nts
SEQ ID NO: 295	Polypeptide encoded by SEQ ID NO: 294	30 aa
SEQ ID NO: 296	ENV segment 8	90 nts
SEQ ID NO: 297	Polypeptide encoded by SEQ ID NO: 296	30 aa
SEQ ID NO: 298	ENV segment 9	57 nts
SEQ ID NO: 299	Polypeptide encoded by SEQ ID NO: 298	19 aa
SEQ ID NO: 300	GAP A segment 1	90 nts
SEQ ID NO: 301	Polypeptide encoded by SEQ ID NO: 300	30 aa
SEQ ID NO: 302	GAP A segment 2	90 nts
SEQ ID NO: 303	Polypeptide encoded by SEQ ID NO: 302	30 aa
SEQ ID NO: 304	GAP A segment 3	90 nts
SEQ ID NO: 305	Polypeptide encoded by SEQ ID NO: 304	30 aa
SEQ ID NO: 306	GAP A segment 4	90 nts
SEQ ID NO: 307	Polypeptide encoded by SEQ ID NO: 306	30 aa
SEQ ID NO: 308	GAP A segment 5	90 nts
SEQ ID NO: 309	Polypeptide encoded by SEQ ID NO: 308	30 aa
SEQ ID NO: 310	GAP A segment 6	90 nts

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SEQUENCE NO NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 311	Polypeptide encoded by SEQ ID NO: 310	30 aa
SEQ ID NO: 312	GAP A segment 7	75 nts
SEQ ID NO: 313	Polypeptide encoded by SEQ ID NO: 312	25 nts
SEQ ID NO: 314	GAP B segment 1	90 nts
SEQ ID NO: 315	Polypeptide encoded by SEQ ID NO: 314	30 aa
SEQ ID NO: 316	GAP B segment 2	90 nts
SEQ ID NO: 317	Polypeptide encoded by SEQ ID NO: 316	30 aa
SEQ ID NO: 318	GAP B segment 3	90 nts
SEQ ID NO: 319	Polypeptide encoded by SEQ ID NO: 318	30 aa
SEQ ID NO: 320	GAP B segment 4	90 nts
SEQ ID NO: 321	Polypeptide encoded by SEQ ID NO: 320	30 aa
SEQ ID NO: 322	GAP B segment 5	90 nts
SEQ ID NO: 323	Polypeptide encoded by SEQ ID NO: 322	30 aa
SEQ ID NO: 324	GAP B segment 6	90 nts
SEQ ID NO: 325	Polypeptide encoded by SEQ ID NO: 324	30 aa
SEQ ID NO: 326	GAP B segment 7	90 nts
SEQ ID NO: 327	Polypeptide encoded by SEQ ID NO: 326	30 aa
SEQ ID NO: 328	GAP B segment 8	90 nts
SEQ ID NO: 329	Polypeptide encoded by SEQ ID NO: 328	30 aa
SEQ ID NO: 330	GAP B segment 9	90 nts
SEQ ID NO: 331	Polypeptide encoded by SEQ ID NO: 330	30 aa
SEQ ID NO: 332	GAP B segment 10	90 nts
SEQ ID NO: 333	Polypeptide encoded by SEQ ID NO: 332	30 aa
SEQ ID NO: 334	GAP B segment 11	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 335	Polypeptide encoded by SEQ ID NO: 334	30 aa
SEQ ID NO: 336	GAP B segment 12	90 nts
SEQ ID NO: 337	Polypeptide encoded by SEQ ID NO: 336	30 aa
SEQ ID NO: 338	GAP B segment 13	90 nts
SEQ ID NO: 339	Polypeptide encoded by SEQ ID NO: 338	30 aa
SEQ ID NO: 340	GAP B segment 14	90 nts
SEQ ID NO: 341	Polypeptide encoded by SEQ ID NO: 340	30 aa
SEQ ID NO: 342	GAP B segment 15	90 nts
SEQ ID NO: 343	Polypeptide encoded by SEQ ID NO: 342	30 aa
SEQ ID NO: 344	GAP B segment 16	90 nts
SEQ ID NO: 345	Polypeptide encoded by SEQ ID NO: 344	30 aa
SEQ ID NO: 346	GAP B segment 17	90 nts
SEQ ID NO: 347	Polypeptide encoded by SEQ ID NO: 346	30 aa
SEQ ID NO: 348	GAP B segment 18	90 nts
SEQ ID NO: 349	Polypeptide encoded by SEQ ID NO: 348	30 aa
SEQ ID NO: 350	GAP B segment 19	90 nts
SEQ ID NO: 351	Polypeptide encoded by SEQ ID NO: 350	30 aa
SEQ ID NO: 352	GAP B segment 20	90 nts
SEQ ID NO: 353	Polypeptide encoded by SEQ ID NO: 352	30 aa
SEQ ID NO: 354	GAP B segment 21	90 nts
SEQ ID NO: 355	Polypeptide encoded by SEQ ID NO: 354	30 aa
SEQ ID NO: 356	GAP B segment 22	90 nts
SEQ ID NO: 357	Polypeptide encoded by SEQ ID NO: 356	30 aa
SEQ ID NO: 358	GAP B segment 23	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 359	Polypeptide encoded by SEQ ID NO: 358	30 aa
SEQ ID NO: 360	GAP B segment 24	90 nts
SEQ ID NO: 361	Polypeptide encoded by SEQ ID NO: 360	30 aa
SEQ ID NO: 362	GAP B segment 25	90 nts
SEQ ID NO: 363	Polypeptide encoded by SEQ ID NO: 362	30 aa
SEQ ID NO: 364	GAP B segment 26	66 nts
SEQ ID NO: 365	Polypeptide encoded by SEQ ID NO: 364	22 aa
SEQ ID NO: 366	NEF segment 1	90 nts
SEQ ID NO: 367	Polypeptide encoded by SEQ ID NO: 366	30 aa
SEQ ID NO: 368	NEF segment 2	90 nts
SEQ ID NO: 369	Polypeptide encoded by SEQ ID NO: 368	30 aa
SEQ ID NO: 370	NEF segment 3	90 nts
SEQ ID NO: 371	Polypeptide encoded by SEQ ID NO: 370	30 aa
SEQ ID NO: 372	NEF segment 4	90 nts
SEQ ID NO: 373	Polypeptide encoded by SEQ ID NO: 372	30 aa
SEQ ID NO: 374	NEF segment 5	90 nts
SEQ ID NO: 375	Polypeptide encoded by SEQ ID NO: 374	30 aa
SEQ ID NO: 376	NEF segment 6	90 nts
SEQ ID NO: 377	Polypeptide encoded by SEQ ID NO: 376	30 aa
SEQ ID NO: 378	NEF segment 7	90 nts
SEQ ID NO: 379	Polypeptide encoded by SEQ ID NO: 378	30 aa
SEQ ID NO: 380	NEF segment 8	90 nts
SEQ ID NO: 381	Polypeptide encoded by SEQ ID NO: 380	30 aa
SEQ ID NO: 382	NEF segment 9	90 nts

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 383	Polypeptide encoded by SEQ ID NO: 382	30 aa
SEQ ID NO: 384	NEF segment 10	90 nts
SEQ ID NO: 385	Polypeptide encoded by SEQ ID NO: 384	30 aa
SEQ ID NO: 386	NEF segment 11	90 nts
SEQ ID NO: 387	Polypeptide encoded by SEQ ID NO: 386	30 aa
SEQ ID NO: 388	NEF segment 12	90 nts
SEQ ID NO: 389	Polypeptide encoded by SEQ ID NO: 388	30 aa
SEQ ID NO: 390	NEF segment 13	78 nts
SEQ ID NO: 391	Polypeptide encoded by SEQ ID NO: 390	26 aa
SEQ ID NO: 392	HIV Cassette A1	5703 nts
SEQ ID NO: 393	Polypeptide encoded by SEQ ID NO: 392	1896 aa
SEQ ID NO: 394	HIV Cassette B1	5685 nts
SEQ ID NO: 395	Polypeptide encoded by SEQ ID NO: 394	1890 aa
SEQ ID NO: 396	HIV Cassette C1	5925 nts
SEQ ID NO: 397	Polypeptide encoded by SEQ ID NO: 396	1967 aa
SEQ ID NO: 398	HIV Cassette A2	5703 nts
SEQ ID NO: 399	Polypeptide encoded by SEQ ID NO: 398	1896 aa
SEQ ID NO: 400	HIV Cassette B2	5685 nts
SEQ ID NO: 401	Polypeptide encoded by SEQ ID NO: 400	1890 aa
SEQ ID NO: 402	HIV Cassette C2	5925 nts
SEQ ID NO: 403	Polypeptide encoded by SEQ ID NO: 402	1967 aa
SEQ ID NO: 404	HIV complete Savine	17244 nts
SEQ ID NO: 405	Polypeptide encoded by SEQ ID NO: 404	5747 aa
SEQ ID NO: 406	HepC1a consensus polyprotein sequence	3011 aa

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 407	HepC1a segment 1	90 nts
SEQ ID NO: 408	Polypeptide encoded by SEQ ID NO: 407	30 aa
SEQ ID NO: 409	HepC1a segment 2	90 nts
SEQ ID NO: 410	Polypeptide encoded by SEQ ID NO: 409	30 aa
SEQ ID NO: 411	HepC1a segment 3	90 nts
SEQ ID NO: 412	Polypeptide encoded by SEQ ID NO: 411	30 aa
SEQ ID NO: 413	HepC1a segment 4	90 nts
SEQ ID NO: 414	Polypeptide encoded by SEQ ID NO: 413	30 aa
SEQ ID NO: 415	HepC1a segment 5	90 nts
SEQ ID NO: 416	Polypeptide encoded by SEQ ID NO: 415	30 aa
SEQ ID NO: 417	HepC1a segment 6	90 nts
SEQ ID NO: 418	Polypeptide encoded by SEQ ID NO: 417	30 aa
SEQ ID NO: 419	HepC1a segment 7	90 nts
SEQ ID NO: 420	Polypeptide encoded by SEQ ID NO: 419	30 aa
SEQ ID NO: 421	HepC1a segment 8	90 nts
SEQ ID NO: 422	Polypeptide encoded by SEQ ID NO: 421	30 aa
SEQ ID NO: 423	HepC1a segment 9	90 nts
SEQ ID NO: 424	Polypeptide encoded by SEQ ID NO: 423	30 aa
SEQ ID NO: 425	HepC1a segment 10	90 nts
SEQ ID NO: 426	Polypeptide encoded by SEQ ID NO: 425	30 aa
SEQ ID NO: 427	HepC1a segment 11	90 nts
SEQ ID NO: 428	Polypeptide encoded by SEQ ID NO: 427	30 aa
SEQ ID NO: 429	HepC1a segment 12	90 nts
SEQ ID NO: 430	Polypeptide encoded by SEQ ID NO: 429	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 431	HepC1a segment 13	90 nts
SEQ ID NO: 432	Polypeptide encoded by SEQ ID NO: 431	30 aa
SEQ ID NO: 433	HepC1a segment 14	90 nts
SEQ ID NO: 434	Polypeptide encoded by SEQ ID NO: 433	30 aa
SEQ ID NO: 435	HepC1a segment 15	90 nts
SEQ ID NO: 436	Polypeptide encoded by SEQ ID NO: 435	30 aa
SEQ ID NO: 437	HepC1a segment 16	90 nts
SEQ ID NO: 438	Polypeptide encoded by SEQ ID NO: 437	30 aa
SEQ ID NO: 439	HepC1a segment 17	90 nts
SEQ ID NO: 440	Polypeptide encoded by SEQ ID NO: 439	30 aa
SEQ ID NO: 441	HepC1a segment 18	90 nts
SEQ ID NO: 442	Polypeptide encoded by SEQ ID NO: 441	30 aa
SEQ ID NO: 443	HepC1a segment 19	90 nts
SEQ ID NO: 444	Polypeptide encoded by SEQ ID NO: 443	30 aa
SEQ ID NO: 445	HepC1a segment 20	90 nts
SEQ ID NO: 446	Polypeptide encoded by SEQ ID NO: 445	30 aa
SEQ ID NO: 447	HepC1a segment 21	90 nts
SEQ ID NO: 448	Polypeptide encoded by SEQ ID NO: 447	30 aa
SEQ ID NO: 449	HepC1a segment 22	90 nts
SEQ ID NO: 450	Polypeptide encoded by SEQ ID NO: 449	30 aa
SEQ ID NO: 451	HepC1a segment 23	90 nts
SEQ ID NO: 452	Polypeptide encoded by SEQ ID NO: 451	30 aa
SEQ ID NO: 453	HepC1a segment 24	90 nts
SEQ ID NO: 454	Polypeptide encoded by SEQ ID NO: 453	30 aa

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SEQ ID NO: NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 455	HepC1a segment 25	90 nts
SEQ ID NO: 456	Polypeptide encoded by SEQ ID NO: 455	30 aa
SEQ ID NO: 457	HepC1a segment 26	90 nts
SEQ ID NO: 458	Polypeptide encoded by SEQ ID NO: 457	30 aa
SEQ ID NO: 459	HepC1a segment 27	90 nts
SEQ ID NO: 460	Polypeptide encoded by SEQ ID NO: 459	30 aa
SEQ ID NO: 461	HepC1a segment 28	90 nts
SEQ ID NO: 462	Polypeptide encoded by SEQ ID NO: 461	30 aa
SEQ ID NO: 463	HepC1a segment 29	90 nts
SEQ ID NO: 464	Polypeptide encoded by SEQ ID NO: 463	30 aa
SEQ ID NO: 465	HepC1a segment 30	90 nts
SEQ ID NO: 466	Polypeptide encoded by SEQ ID NO: 465	30 aa
SEQ ID NO: 467	HepC1a segment 31	90 nts
SEQ ID NO: 468	Polypeptide encoded by SEQ ID NO: 467	30 aa
SEQ ID NO: 469	HepC1a segment 32	90 nts
SEQ ID NO: 470	Polypeptide encoded by SEQ ID NO: 469	30 aa
SEQ ID NO: 471	HepC1a segment 33	90 nts
SEQ ID NO: 472	Polypeptide encoded by SEQ ID NO: 471	30 aa
SEQ ID NO: 473	HepC1a segment 34	90 nts
SEQ ID NO: 474	Polypeptide encoded by SEQ ID NO: 473	30 aa
SEQ ID NO: 475	HepC1a segment 35	90 nts
SEQ ID NO: 476	Polypeptide encoded by SEQ ID NO: 475	30 aa
SEQ ID NO: 477	HepC1a segment 36	90 nts
SEQ ID NO: 478	Polypeptide encoded by SEQ ID NO: 477	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 479	HepC1a segment 37	90 nts
SEQ ID NO: 480	Polypeptide encoded by SEQ ID NO: 479	30 aa
SEQ ID NO: 481	HepC1a segment 38	90 nts
SEQ ID NO: 482	Polypeptide encoded by SEQ ID NO: 481	30 aa
SEQ ID NO: 483	HepC1a segment 39	90 nts
SEQ ID NO: 484	Polypeptide encoded by SEQ ID NO: 483	30 aa
SEQ ID NO: 485	HepC1a segment 40	90 nts
SEQ ID NO: 486	Polypeptide encoded by SEQ ID NO: 485	30 aa
SEQ ID NO: 487	HepC1a segment 41	90 nts
SEQ ID NO: 488	Polypeptide encoded by SEQ ID NO: 487	30 aa
SEQ ID NO: 489	HepC1a segment 42	90 nts
SEQ ID NO: 490	Polypeptide encoded by SEQ ID NO: 489	30 aa
SEQ ID NO: 491	HepC1a segment 43	90 nts
SEQ ID NO: 492	Polypeptide encoded by SEQ ID NO: 491	30 aa
SEQ ID NO: 493	HepC1a segment 44	90 nts
SEQ ID NO: 494	Polypeptide encoded by SEQ ID NO: 493	30 aa
SEQ ID NO: 495	HepC1a segment 45	90 nts
SEQ ID NO: 496	Polypeptide encoded by SEQ ID NO: 495	30 aa
SEQ ID NO: 497	HepC1a segment 46	90 nts
SEQ ID NO: 498	Polypeptide encoded by SEQ ID NO: 497	30 aa
SEQ ID NO: 499	HepC1a segment 47	90 nts
SEQ ID NO: 500	Polypeptide encoded by SEQ ID NO: 499	30 aa
SEQ ID NO: 501	HepC1a segment 48	90 nts
SEQ ID NO: 502	Polypeptide encoded by SEQ ID NO: 501	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 503	HepC1a segment 49	90 nts
SEQ ID NO: 504	Polypeptide encoded by SEQ ID NO: 503	30 aa
SEQ ID NO: 505	HepC1a segment 50	90 nts
SEQ ID NO: 506	Polypeptide encoded by SEQ ID NO: 505	30 aa
SEQ ID NO: 507	HepC1a segment 51	90 nts
SEQ ID NO: 508	Polypeptide encoded by SEQ ID NO: 507	30 aa
SEQ ID NO: 509	HepC1a segment 52	90 nts
SEQ ID NO: 510	Polypeptide encoded by SEQ ID NO: 509	30 aa
SEQ ID NO: 511	HepC1a segment 53	90 nts
SEQ ID NO: 512	Polypeptide encoded by SEQ ID NO: 511	30 aa
SEQ ID NO: 513	HepC1a segment 54	90 nts
SEQ ID NO: 514	Polypeptide encoded by SEQ ID NO: 513	30 aa
SEQ ID NO: 515	HepC1a segment 55	90 nts
SEQ ID NO: 516	Polypeptide encoded by SEQ ID NO: 515	30 aa
SEQ ID NO: 517	HepC1a segment 56	90 nts
SEQ ID NO: 518	Polypeptide encoded by SEQ ID NO: 517	30 aa
SEQ ID NO: 519	HepC1a segment 57	90 nts
SEQ ID NO: 520	Polypeptide encoded by SEQ ID NO: 519	30 aa
SEQ ID NO: 521	HepC1a segment 58	90 nts
SEQ ID NO: 522	Polypeptide encoded by SEQ ID NO: 521	30 aa
SEQ ID NO: 523	HepC1a segment 59	90 nts
SEQ ID NO: 524	Polypeptide encoded by SEQ ID NO: 523	30 aa
SEQ ID NO: 525	HepC1a segment 60	90 nts
SEQ ID NO: 526	Polypeptide encoded by SEQ ID NO: 525	30 aa

SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 527	HepC1a segment 61	90 nts
SEQ ID NO: 528	Polypeptide encoded by SEQ ID NO: 527	30 aa
SEQ ID NO: 529	HepC1a segment 62	90 nts
SEQ ID NO: 530	Polypeptide encoded by SEQ ID NO: 529	30 aa
SEQ ID NO: 531	HepC1a segment 63	90 nts
SEQ ID NO: 532	Polypeptide encoded by SEQ ID NO: 531	30 aa
SEQ ID NO: 533	HepC1a segment 64	90 nts
SEQ ID NO: 534	Polypeptide encoded by SEQ ID NO: 533	30 aa
SEQ ID NO: 535	HepC1a segment 65	90 nts
SEQ ID NO: 536	Polypeptide encoded by SEQ ID NO: 535	30 aa
SEQ ID NO: 537	HepC1a segment 66	90 nts
SEQ ID NO: 538	Polypeptide encoded by SEQ ID NO: 537	30 aa
SEQ ID NO: 539	HepC1a segment 67	90 nts
SEQ ID NO: 540	Polypeptide encoded by SEQ ID NO: 539	30 aa
SEQ ID NO: 541	HepC1a segment 68	90 nts
SEQ ID NO: 542	Polypeptide encoded by SEQ ID NO: 541	30 aa
SEQ ID NO: 543	HepC1a segment 69	90 nts
SEQ ID NO: 544	Polypeptide encoded by SEQ ID NO: 543	30 aa
SEQ ID NO: 545	HepC1a segment 70	90 nts
SEQ ID NO: 546	Polypeptide encoded by SEQ ID NO: 545	30 aa
SEQ ID NO: 547	HepC1a segment 71	90 nts
SEQ ID NO: 548	Polypeptide encoded by SEQ ID NO: 547	30 aa
SEQ ID NO: 549	HepC1a segment 72	90 nts
SEQ ID NO: 550	Polypeptide encoded by SEQ ID NO: 549	30 aa

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 551	HepC1a segment 73	90 nts
SEQ ID NO: 552	Polypeptide encoded by SEQ ID NO: 551	30 aa
SEQ ID NO: 553	HepC1a segment 74	90 nts
SEQ ID NO: 554	Polypeptide encoded by SEQ ID NO: 553	30 aa
SEQ ID NO: 555	HepC1a segment 75	90 nts
SEQ ID NO: 556	Polypeptide encoded by SEQ ID NO: 555	30 aa
SEQ ID NO: 557	HepC1a segment 76	90 nts
SEQ ID NO: 558	Polypeptide encoded by SEQ ID NO: 557	30 aa
SEQ ID NO: 559	HepC1a segment 77	90 nts
SEQ ID NO: 560	Polypeptide encoded by SEQ ID NO: 559	30 aa
SEQ ID NO: 561	HepC1a segment 78	90 nts
SEQ ID NO: 562	Polypeptide encoded by SEQ ID NO: 561	30 aa
SEQ ID NO: 563	HepC1a segment 79	90 nts
SEQ ID NO: 564	Polypeptide encoded by SEQ ID NO: 563	30 aa
SEQ ID NO: 565	HepC1a segment 80	90 nts
SEQ ID NO: 566	Polypeptide encoded by SEQ ID NO: 565	30 aa
SEQ ID NO: 567	HepC1a segment 81	90 nts
SEQ ID NO: 568	Polypeptide encoded by SEQ ID NO: 567	30 aa
SEQ ID NO: 569	HepC1a segment 82	90 nts
SEQ ID NO: 570	Polypeptide encoded by SEQ ID NO: 569	30 aa
SEQ ID NO: 571	HepC1a segment 83	90 nts
SEQ ID NO: 572	Polypeptide encoded by SEQ ID NO: 571	30 aa
SEQ ID NO: 573	HepC1a segment 84	90 nts
SEQ ID NO: 574	Polypeptide encoded by SEQ ID NO: 573	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 575	HepC1a segment 85	90 nts
SEQ ID NO: 576	Polypeptide encoded by SEQ ID NO: 575	30 aa
SEQ ID NO: 577	HepC1a segment 86	90 nts
SEQ ID NO: 578	Polypeptide encoded by SEQ ID NO: 577	30 aa
SEQ ID NO: 579	HepC1a segment 87	90 nts
SEQ ID NO: 580	Polypeptide encoded by SEQ ID NO: 579	30 aa
SEQ ID NO: 581	HepC1a segment 88	90 nts
SEQ ID NO: 582	Polypeptide encoded by SEQ ID NO: 581	30 aa
SEQ ID NO: 583	HepC1a segment 89	90 nts
SEQ ID NO: 584	Polypeptide encoded by SEQ ID NO: 583	30 aa
SEQ ID NO: 585	HepC1a segment 90	90 nts
SEQ ID NO: 586	Polypeptide encoded by SEQ ID NO: 585	30 aa
SEQ ID NO: 587	HepC1a segment 91	90 nts
SEQ ID NO: 588	Polypeptide encoded by SEQ ID NO: 587	30 aa
SEQ ID NO: 589	HepC1a segment 92	90 nts
SEQ ID NO: 590	Polypeptide encoded by SEQ ID NO: 589	30 aa
SEQ ID NO: 591	HepC1a segment 93	90 nts
SEQ ID NO: 592	Polypeptide encoded by SEQ ID NO: 591	30 aa
SEQ ID NO: 593	HepC1a segment 94	90 nts
SEQ ID NO: 594	Polypeptide encoded by SEQ ID NO: 593	30 aa
SEQ ID NO: 595	HepC1a segment 95	90 nts
SEQ ID NO: 596	Polypeptide encoded by SEQ ID NO: 595	30 aa
SEQ ID NO: 597	HepC1a segment 96	90 nts
SEQ ID NO: 598	Polypeptide encoded by SEQ ID NO: 597	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 599	HepC1a segment 97	90 nts
SEQ ID NO: 600	Polypeptide encoded by SEQ ID NO: 599	30 aa
SEQ ID NO: 601	HepC1a segment 98	90 nts
SEQ ID NO: 602	Polypeptide encoded by SEQ ID NO: 601	30 aa
SEQ ID NO: 603	HepC1a segment 99	90 nts
SEQ ID NO: 604	Polypeptide encoded by SEQ ID NO: 603	30 aa
SEQ ID NO: 605	HepC1a segment 100	90 nts
SEQ ID NO: 606	Polypeptide encoded by SEQ ID NO: 605	30 aa
SEQ ID NO: 607	HepC1a segment 101	90 nts
SEQ ID NO: 608	Polypeptide encoded by SEQ ID NO: 607	30 aa
SEQ ID NO: 609	HepC1a segment 102	90 nts
SEQ ID NO: 610	Polypeptide encoded by SEQ ID NO: 609	30 aa
SEQ ID NO: 611	HepC1a segment 103	90 nts
SEQ ID NO: 612	Polypeptide encoded by SEQ ID NO: 611	30 aa
SEQ ID NO: 613	HepC1a segment 104	90 nts
SEQ ID NO: 614	Polypeptide encoded by SEQ ID NO: 613	30 aa
SEQ ID NO: 615	HepC1a segment 105	90 nts
SEQ ID NO: 616	Polypeptide encoded by SEQ ID NO: 615	30 aa
SEQ ID NO: 617	HepC1a segment 106	90 nts
SEQ ID NO: 618	Polypeptide encoded by SEQ ID NO: 617	30 aa
SEQ ID NO: 619	HepC1a segment 107	90 nts
SEQ ID NO: 620	Polypeptide encoded by SEQ ID NO: 619	30 aa
SEQ ID NO: 621	HepC1a segment 108	90 nts
SEQ ID NO: 622	Polypeptide encoded by SEQ ID NO: 621	30 aa

SEQUENCE NO.	SEQUENCE	LENGTH
SEQ ID NO: 623	HepC1a segment 109	90 nts
SEQ ID NO: 624	Polypeptide encoded by SEQ ID NO: 623	30 aa
SEQ ID NO: 625	HepC1a segment 110	90 nts
SEQ ID NO: 626	Polypeptide encoded by SEQ ID NO: 625	30 aa
SEQ ID NO: 627	HepC1a segment 111	90 nts
SEQ ID NO: 628	Polypeptide encoded by SEQ ID NO: 627	30 aa
SEQ ID NO: 629	HepC1a segment 112	90 nts
SEQ ID NO: 630	Polypeptide encoded by SEQ ID NO: 629	30 aa
SEQ ID NO: 631	HepC1a segment 113	90 nts
SEQ ID NO: 632	Polypeptide encoded by SEQ ID NO: 631	30 aa
SEQ ID NO: 633	HepC1a segment 114	90 nts
SEQ ID NO: 634	Polypeptide encoded by SEQ ID NO: 633	30 aa
SEQ ID NO: 635	HepC1a segment 115	90 nts
SEQ ID NO: 636	Polypeptide encoded by SEQ ID NO: 635	30 aa
SEQ ID NO: 637	HepC1a segment 116	90 nts
SEQ ID NO: 638	Polypeptide encoded by SEQ ID NO: 637	30 aa
SEQ ID NO: 639	HepC1a segment 117	90 nts
SEQ ID NO: 640	Polypeptide encoded by SEQ ID NO: 639	30 aa
SEQ ID NO: 641	HepC1a segment 118	90 nts
SEQ ID NO: 642	Polypeptide encoded by SEQ ID NO: 641	30 aa
SEQ ID NO: 643	HepC1a segment 119	90 nts
SEQ ID NO: 644	Polypeptide encoded by SEQ ID NO: 643	30 aa
SEQ ID NO: 645	HepC1a segment 120	90 nts
SEQ ID NO: 646	Polypeptide encoded by SEQ ID NO: 645	30 aa

SEQUENCE ID NO.	SEQUENCE	LENGTH
SEQ ID NO: 647	HepC1a segment 121	90 nts
SEQ ID NO: 648	Polypeptide encoded by SEQ ID NO: 647	30 aa
SEQ ID NO: 649	HepC1a segment 122	90 nts
SEQ ID NO: 650	Polypeptide encoded by SEQ ID NO: 649	30 aa
SEQ ID NO: 651	HepC1a segment 123	90 nts
SEQ ID NO: 652	Polypeptide encoded by SEQ ID NO: 651	30 aa
SEQ ID NO: 653	HepC1a segment 124	90 nts
SEQ ID NO: 654	Polypeptide encoded by SEQ ID NO: 653	30 aa
SEQ ID NO: 655	HepC1a segment 125	90 nts
SEQ ID NO: 656	Polypeptide encoded by SEQ ID NO: 655	30 aa
SEQ ID NO: 657	HepC1a segment 126	90 nts
SEQ ID NO: 658	Polypeptide encoded by SEQ ID NO: 657	30 aa
SEQ ID NO: 659	HepC1a segment 127	90 nts
SEQ ID NO: 660	Polypeptide encoded by SEQ ID NO: 659	30 aa
SEQ ID NO: 661	HepC1a segment 128	90 nts
SEQ ID NO: 662	Polypeptide encoded by SEQ ID NO: 661	30 aa
SEQ ID NO: 663	HepC1a segment 129	90 nts
SEQ ID NO: 664	Polypeptide encoded by SEQ ID NO: 663	30 aa
SEQ ID NO: 665	HepC1a segment 130	90 nts
SEQ ID NO: 666	Polypeptide encoded by SEQ ID NO: 665	30 aa
SEQ ID NO: 667	HepC1a segment 131	90 nts
SEQ ID NO: 668	Polypeptide encoded by SEQ ID NO: 667	30 aa
SEQ ID NO: 669	HepC1a segment 132	90 nts
SEQ ID NO: 670	Polypeptide encoded by SEQ ID NO: 669	30 aa

SEQUENCIA NÚMERO	SEQUENCE	LENGTH
SEQ ID NO: 671	HepC1a segment 133	90 nts
SEQ ID NO: 672	Polypeptide encoded by SEQ ID NO: 671	30 aa
SEQ ID NO: 673	HepC1a segment 134	90 nts
SEQ ID NO: 674	Polypeptide encoded by SEQ ID NO: 673	30 aa
SEQ ID NO: 675	HepC1a segment 135	90 nts
SEQ ID NO: 676	Polypeptide encoded by SEQ ID NO: 675	30 aa
SEQ ID NO: 677	HepC1a segment 136	90 nts
SEQ ID NO: 678	Polypeptide encoded by SEQ ID NO: 677	30 aa
SEQ ID NO: 679	HepC1a segment 137	90 nts
SEQ ID NO: 680	Polypeptide encoded by SEQ ID NO: 679	30 aa
SEQ ID NO: 681	HepC1a segment 138	90 nts
SEQ ID NO: 682	Polypeptide encoded by SEQ ID NO: 681	30 aa
SEQ ID NO: 683	HepC1a segment 139	90 nts
SEQ ID NO: 684	Polypeptide encoded by SEQ ID NO: 683	30 aa
SEQ ID NO: 685	HepC1a segment 140	90 nts
SEQ ID NO: 686	Polypeptide encoded by SEQ ID NO: 685	30 aa
SEQ ID NO: 687	HepC1a segment 141	90 nts
SEQ ID NO: 688	Polypeptide encoded by SEQ ID NO: 687	30 aa
SEQ ID NO: 689	HepC1a segment 142	90 nts
SEQ ID NO: 690	Polypeptide encoded by SEQ ID NO: 689	30 aa
SEQ ID NO: 691	HepC1a segment 143	90 nts
SEQ ID NO: 692	Polypeptide encoded by SEQ ID NO: 691	30 aa
SEQ ID NO: 693	HepC1a segment 144	90 nts
SEQ ID NO: 694	Polypeptide encoded by SEQ ID NO: 693	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 695	HepC1a segment 145	90 nts
SEQ ID NO: 696	Polypeptide encoded by SEQ ID NO: 695	30 aa
SEQ ID NO: 697	HepC1a segment 146	90 nts
SEQ ID NO: 698	Polypeptide encoded by SEQ ID NO: 697	30 aa
SEQ ID NO: 699	HepC1a segment 147	90 nts
SEQ ID NO: 700	Polypeptide encoded by SEQ ID NO: 699	30 aa
SEQ ID NO: 701	HepC1a segment 148	90 nts
SEQ ID NO: 702	Polypeptide encoded by SEQ ID NO: 701	30 aa
SEQ ID NO: 703	HepC1a segment 149	90 nts
SEQ ID NO: 704	Polypeptide encoded by SEQ ID NO: 703	30 aa
SEQ ID NO: 705	HepC1a segment 150	90 nts
SEQ ID NO: 706	Polypeptide encoded by SEQ ID NO: 705	30 aa
SEQ ID NO: 707	HepC1a segment 151	90 nts
SEQ ID NO: 708	Polypeptide encoded by SEQ ID NO: 707	30 aa
SEQ ID NO: 709	HepC1a segment 152	90 nts
SEQ ID NO: 710	Polypeptide encoded by SEQ ID NO: 709	30 aa
SEQ ID NO: 711	HepC1a segment 153	90 nts
SEQ ID NO: 712	Polypeptide encoded by SEQ ID NO: 711	30 aa
SEQ ID NO: 713	HepC1a segment 154	90 nts
SEQ ID NO: 714	Polypeptide encoded by SEQ ID NO: 713	30 aa
SEQ ID NO: 715	HepC1a segment 155	90 nts
SEQ ID NO: 716	Polypeptide encoded by SEQ ID NO: 715	30 aa
SEQ ID NO: 717	HepC1a segment 156	90 nts
SEQ ID NO: 718	Polypeptide encoded by SEQ ID NO: 717	30 aa

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 719	HepC1a segment 157	90 nts
SEQ ID NO: 720	Polypeptide encoded by SEQ ID NO: 719	30 aa
SEQ ID NO: 721	HepC1a segment 158	90 nts
SEQ ID NO: 722	Polypeptide encoded by SEQ ID NO: 721	30 aa
SEQ ID NO: 723	HepC1a segment 159	90 nts
SEQ ID NO: 724	Polypeptide encoded by SEQ ID NO: 723	30 aa
SEQ ID NO: 725	HepC1a segment 160	90 nts
SEQ ID NO: 726	Polypeptide encoded by SEQ ID NO: 725	30 aa
SEQ ID NO: 727	HepC1a segment 161	90 nts
SEQ ID NO: 728	Polypeptide encoded by SEQ ID NO: 727	30 aa
SEQ ID NO: 729	HepC1a segment 162	90 nts
SEQ ID NO: 730	Polypeptide encoded by SEQ ID NO: 729	30 aa
SEQ ID NO: 731	HepC1a segment 163	90 nts
SEQ ID NO: 732	Polypeptide encoded by SEQ ID NO: 731	30 aa
SEQ ID NO: 733	HepC1a segment 164	90 nts
SEQ ID NO: 734	Polypeptide encoded by SEQ ID NO: 733	30 aa
SEQ ID NO: 735	HepC1a segment 165	90 nts
SEQ ID NO: 736	Polypeptide encoded by SEQ ID NO: 735	30 aa
SEQ ID NO: 737	HepC1a segment 166	90 nts
SEQ ID NO: 738	Polypeptide encoded by SEQ ID NO: 737	30 aa
SEQ ID NO: 739	HepC1a segment 167	90 nts
SEQ ID NO: 740	Polypeptide encoded by SEQ ID NO: 739	30 aa
SEQ ID NO: 741	HepC1a segment 168	90 nts
SEQ ID NO: 742	Polypeptide encoded by SEQ ID NO: 741	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 743	HepC1a segment 169	90 nts
SEQ ID NO: 744	Polypeptide encoded by SEQ ID NO: 743	30 aa
SEQ ID NO: 745	HepC1a segment 170	90 nts
SEQ ID NO: 746	Polypeptide encoded by SEQ ID NO: 745	30 aa
SEQ ID NO: 747	HepC1a segment 171	90 nts
SEQ ID NO: 748	Polypeptide encoded by SEQ ID NO: 747	30 aa
SEQ ID NO: 749	HepC1a segment 172	90 nts
SEQ ID NO: 750	Polypeptide encoded by SEQ ID NO: 749	30 aa
SEQ ID NO: 751	HepC1a segment 173	90 nts
SEQ ID NO: 752	Polypeptide encoded by SEQ ID NO: 751	30 aa
SEQ ID NO: 753	HepC1a segment 174	90 nts
SEQ ID NO: 754	Polypeptide encoded by SEQ ID NO: 753	30 aa
SEQ ID NO: 755	HepC1a segment 175	90 nts
SEQ ID NO: 756	Polypeptide encoded by SEQ ID NO: 755	30 aa
SEQ ID NO: 757	HepC1a segment 176	90 nts
SEQ ID NO: 758	Polypeptide encoded by SEQ ID NO: 757	30 aa
SEQ ID NO: 759	HepC1a segment 177	90 nts
SEQ ID NO: 760	Polypeptide encoded by SEQ ID NO: 759	30 aa
SEQ ID NO: 761	HepC1a segment 178	90 nts
SEQ ID NO: 762	Polypeptide encoded by SEQ ID NO: 761	30 aa
SEQ ID NO: 763	HepC1a segment 179	90 nts
SEQ ID NO: 764	Polypeptide encoded by SEQ ID NO: 763	30 aa
SEQ ID NO: 765	HepC1a segment 180	90 nts
SEQ ID NO: 766	Polypeptide encoded by SEQ ID NO: 765	30 aa

SEQUENCE ID NO.	SEQUENCE	LENGTH
SEQ ID NO: 767	HepC1a segment 181	90 nts
SEQ ID NO: 768	Polypeptide encoded by SEQ ID NO: 767	30 aa
SEQ ID NO: 769	HepC1a segment 182	90 nts
SEQ ID NO: 770	Polypeptide encoded by SEQ ID NO: 769	30 aa
SEQ ID NO: 771	HepC1a segment 183	90 nts
SEQ ID NO: 772	Polypeptide encoded by SEQ ID NO: 771	30 aa
SEQ ID NO: 773	HepC1a segment 184	90 nts
SEQ ID NO: 774	Polypeptide encoded by SEQ ID NO: 773	30 aa
SEQ ID NO: 775	HepC1a segment 185	90 nts
SEQ ID NO: 776	Polypeptide encoded by SEQ ID NO: 775	30 aa
SEQ ID NO: 777	HepC1a segment 186	90 nts
SEQ ID NO: 778	Polypeptide encoded by SEQ ID NO: 777	30 aa
SEQ ID NO: 779	HepC1a segment 187	90 nts
SEQ ID NO: 780	Polypeptide encoded by SEQ ID NO: 779	30 aa
SEQ ID NO: 781	HepC1a segment 188	90 nts
SEQ ID NO: 782	Polypeptide encoded by SEQ ID NO: 781	30 aa
SEQ ID NO: 783	HepC1a segment 189	90 nts
SEQ ID NO: 784	Polypeptide encoded by SEQ ID NO: 783	30 aa
SEQ ID NO: 785	HepC1a segment 190	90 nts
SEQ ID NO: 786	Polypeptide encoded by SEQ ID NO: 785	30 aa
SEQ ID NO: 787	HepC1a segment 191	90 nts
SEQ ID NO: 788	Polypeptide encoded by SEQ ID NO: 787	30 aa
SEQ ID NO: 789	HepC1a segment 192	90 nts
SEQ ID NO: 790	Polypeptide encoded by SEQ ID NO: 789	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 791	HepC1a segment 193	90 nts
SEQ ID NO: 792	Polypeptide encoded by SEQ ID NO: 791	30 aa
SEQ ID NO: 793	HepC1a segment 194	90 nts
SEQ ID NO: 794	Polypeptide encoded by SEQ ID NO: 793	30 aa
SEQ ID NO: 795	HepC1a segment 195	90 nts
SEQ ID NO: 796	Polypeptide encoded by SEQ ID NO: 795	30 aa
SEQ ID NO: 797	HepC1a segment 196	90 nts
SEQ ID NO: 798	Polypeptide encoded by SEQ ID NO: 797	30 aa
SEQ ID NO: 799	HepC1a segment 197	90 nts
SEQ ID NO: 800	Polypeptide encoded by SEQ ID NO: 799	30 aa
SEQ ID NO: 801	HepC1a segment 198	90 nts
SEQ ID NO: 802	Polypeptide encoded by SEQ ID NO: 801	30 aa
SEQ ID NO: 803	HepC1a segment 199	90 nts
SEQ ID NO: 804	Polypeptide encoded by SEQ ID NO: 803	30 aa
SEQ ID NO: 805	HepC1a segment 200	90 nts
SEQ ID NO: 806	Polypeptide encoded by SEQ ID NO: 805	30 aa
SEQ ID NO: 807	HepC1a segment 201	45 nts
SEQ ID NO: 808	Polypeptide encoded by SEQ ID NO: 807	15 aa
SEQ ID NO: 809	HepC1a scrambled	17955 nts
SEQ ID NO: 810	Polypeptide encoded by SEQ ID NO: 809	5985 aa
SEQ ID NO: 811	HepC Cassette A	6065 nts
SEQ ID NO: 812	Polypeptide encoded by SEQ ID NO: 811	2011 aa
SEQ ID NO: 813	HepC Cassette B	6069 nts
SEQ ID NO: 814	Polypeptide encoded by SEQ ID NO: 813	2010 aa

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 815	HepC Cassette C	6030 nts
SEQ ID NO: 816	Polypeptide encoded by SEQ ID NO: 815	1997 aa
SEQ ID NO: 817	gp100 consensus polypeptide	661 aa
SEQ ID NO: 818	MART consensus polypeptide	118 aa
SEQ ID NO: 819	TRP-1 consensus polypeptide	248 aa
SEQ ID NO: 820	Tyros consensus polypeptide	529 aa
SEQ ID NO: 821	TRP2 consensus polypeptide	519 aa
SEQ ID NO: 822	MC1R consensus polypeptide	317 aa
SEQ ID NO: 823	MUC1F consensus polypeptide	125 aa
SEQ ID NO: 824	MUC1R consensus polypeptide	312 aa
SEQ ID NO: 825	BAGE consensus polypeptide	43 aa
SEQ ID NO: 826	GAGE-1 consensus polypeptide	138 aa
SEQ ID NO: 827	gp100ln4 consensus polypeptide	51 aa
SEQ ID NO: 828	MAGE-1 consensus polypeptide	309 aa
SEQ ID NO: 829	MAGE-3 consensus polypeptide	314 aa
SEQ ID NO: 830	PRAME consensus polypeptide	509 aa
SEQ ID NO: 831	TRP2IN2 consensus polypeptide	54 aa
SEQ ID NO: 832	NYNSO1a consensus polypeptide	180 aa
SEQ ID NO: 833	NYNSO1b consensus polypeptide	58 aa
SEQ ID NO: 834	LAGE1 consensus polypeptide	180 aa
SEQ ID NO: 835	gp100 segment 1	90 nts
SEQ ID NO: 836	Polypeptide encoded by SEQ ID NO: 835	30 aa
SEQ ID NO: 837	gp100 segment 2	90 nts
SEQ ID NO: 838	Polypeptide encoded by SEQ ID NO: 837	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 839	gp100 segment 3	90 nts
SEQ ID NO: 840	Polypeptide encoded by SEQ ID NO: 839	30 aa
SEQ ID NO: 841	gp100 segment 4	90 nts
SEQ ID NO: 842	Polypeptide encoded by SEQ ID NO: 841	30 aa
SEQ ID NO: 843	gp100 segment 5	90 nts
SEQ ID NO: 844	Polypeptide encoded by SEQ ID NO: 843	30 aa
SEQ ID NO: 845	gp100 segment 6	90 nts
SEQ ID NO: 846	Polypeptide encoded by SEQ ID NO: 845	30 aa
SEQ ID NO: 847	gp100 segment 7	90 nts
SEQ ID NO: 848	Polypeptide encoded by SEQ ID NO: 847	30 aa
SEQ ID NO: 849	gp100 segment 8	90 nts
SEQ ID NO: 850	Polypeptide encoded by SEQ ID NO: 849	30 aa
SEQ ID NO: 851	gp100 segment 9	90 nts
SEQ ID NO: 852	Polypeptide encoded by SEQ ID NO: 851	30 aa
SEQ ID NO: 853	gp100 segment 10	90 nts
SEQ ID NO: 854	Polypeptide encoded by SEQ ID NO: 853	30 aa
SEQ ID NO: 855	gp100 segment 11	90 nts
SEQ ID NO: 856	Polypeptide encoded by SEQ ID NO: 855	30 aa
SEQ ID NO: 857	gp100 segment 12	90 nts
SEQ ID NO: 858	Polypeptide encoded by SEQ ID NO: 857	30 aa
SEQ ID NO: 859	gp100 segment 13	90 nts
SEQ ID NO: 860	Polypeptide encoded by SEQ ID NO: 859	30 aa
SEQ ID NO: 861	gp100 segment 14	90 nts
SEQ ID NO: 862	Polypeptide encoded by SEQ ID NO: 861	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 863	gp100 segment 15	90 nts
SEQ ID NO: 864	Polypeptide encoded by SEQ ID NO: 863	30 aa
SEQ ID NO: 865	gp100 segment 16	90 nts
SEQ ID NO: 866	Polypeptide encoded by SEQ ID NO: 865	30 aa
SEQ ID NO: 867	gp100 segment 17	90 nts
SEQ ID NO: 868	Polypeptide encoded by SEQ ID NO: 867	30 aa
SEQ ID NO: 869	gp100 segment 18	90 nts
SEQ ID NO: 870	Polypeptide encoded by SEQ ID NO: 869	30 aa
SEQ ID NO: 871	gp100 segment 19	90 nts
SEQ ID NO: 872	Polypeptide encoded by SEQ ID NO: 871	30 aa
SEQ ID NO: 873	gp100 segment 20	90 nts
SEQ ID NO: 874	Polypeptide encoded by SEQ ID NO: 873	30 aa
SEQ ID NO: 875	gp100 segment 21	90 nts
SEQ ID NO: 876	Polypeptide encoded by SEQ ID NO: 875	30 aa
SEQ ID NO: 877	gp100 segment 22	90 nts
SEQ ID NO: 878	Polypeptide encoded by SEQ ID NO: 877	30 aa
SEQ ID NO: 879	gp100 segment 23	90 nts
SEQ ID NO: 880	Polypeptide encoded by SEQ ID NO: 879	30 aa
SEQ ID NO: 881	gp100 segment 24	90 nts
SEQ ID NO: 882	Polypeptide encoded by SEQ ID NO: 881	30 aa
SEQ ID NO: 883	gp100 segment 25	90 nts
SEQ ID NO: 884	Polypeptide encoded by SEQ ID NO: 883	30 aa
SEQ ID NO: 885	gp100 segment 26	90 nts
SEQ ID NO: 886	Polypeptide encoded by SEQ ID NO: 885	30 aa

SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 887	gp100 segment 27	90 nts
SEQ ID NO: 888	Polypeptide encoded by SEQ ID NO: 887	30 aa
SEQ ID NO: 889	gp100 segment 28	90 nts
SEQ ID NO: 890	Polypeptide encoded by SEQ ID NO: 889	30 aa
SEQ ID NO: 891	gp100 segment 29	90 nts
SEQ ID NO: 892	Polypeptide encoded by SEQ ID NO: 891	30 aa
SEQ ID NO: 893	gp100 segment 30	90 nts
SEQ ID NO: 894	Polypeptide encoded by SEQ ID NO: 893	30 aa
SEQ ID NO: 895	gp100 segment 31	90 nts
SEQ ID NO: 896	Polypeptide encoded by SEQ ID NO: 895	30 aa
SEQ ID NO: 897	gp100 segment 32	90 nts
SEQ ID NO: 898	Polypeptide encoded by SEQ ID NO: 897	30 aa
SEQ ID NO: 899	gp100 segment 33	90 nts
SEQ ID NO: 900	Polypeptide encoded by SEQ ID NO: 899	30 aa
SEQ ID NO: 901	gp100 segment 34	90 nts
SEQ ID NO: 902	Polypeptide encoded by SEQ ID NO: 901	30 aa
SEQ ID NO: 903	gp100 segment 35	90 nts
SEQ ID NO: 904	Polypeptide encoded by SEQ ID NO: 903	30 aa
SEQ ID NO: 905	gp100 segment 36	90 nts
SEQ ID NO: 906	Polypeptide encoded by SEQ ID NO: 905	30 aa
SEQ ID NO: 907	gp100 segment 37	90 nts
SEQ ID NO: 908	Polypeptide encoded by SEQ ID NO: 907	30 aa
SEQ ID NO: 909	gp100 segment 38	90 nts
SEQ ID NO: 910	Polypeptide encoded by SEQ ID NO: 909	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 911	gp100 segment 39	90 nts
SEQ ID NO: 912	Polypeptide encoded by SEQ ID NO: 911	30 aa
SEQ ID NO: 913	gp100 segment 40	90 nts
SEQ ID NO: 914	Polypeptide encoded by SEQ ID NO: 913	30 aa
SEQ ID NO: 915	gp100 segment 41	90 nts
SEQ ID NO: 916	Polypeptide encoded by SEQ ID NO: 915	30 aa
SEQ ID NO: 917	gp100 segment 42	90 nts
SEQ ID NO: 918	Polypeptide encoded by SEQ ID NO: 917	30 aa
SEQ ID NO: 919	gp100 segment 43	90 nts
SEQ ID NO: 920	Polypeptide encoded by SEQ ID NO: 919	30 aa
SEQ ID NO: 921	gp100 segment 44	60nts
SEQ ID NO: 922	Polypeptide encoded by SEQ ID NO: 921	20 aa
SEQ ID NO: 923	MART segment 1	90 nts
SEQ ID NO: 924	Polypeptide encoded by SEQ ID NO: 923	30 aa
SEQ ID NO: 925	MART segment 2	90 nts
SEQ ID NO: 926	Polypeptide encoded by SEQ ID NO: 925	30 aa
SEQ ID NO: 927	MART segment 3	90 nts
SEQ ID NO: 928	Polypeptide encoded by SEQ ID NO: 927	30 aa
SEQ ID NO: 929	MART segment 4	90 nts
SEQ ID NO: 930	Polypeptide encoded by SEQ ID NO: 929	30 aa
SEQ ID NO: 931	MART segment 5	90 nts
SEQ ID NO: 932	Polypeptide encoded by SEQ ID NO: 931	30 aa
SEQ ID NO: 933	MART segment 6	90 nts
SEQ ID NO: 934	Polypeptide encoded by SEQ ID NO: 933	30 aa

SEQ ID NO	DESCRIPTION	LENGTH
SEQ ID NO: 935	MART segment 7	90 nts
SEQ ID NO: 936	Polypeptide encoded by SEQ ID NO: 935	30 aa
SEQ ID NO: 937	MART segment 8	51 nts
SEQ ID NO: 938	Polypeptide encoded by SEQ ID NO: 937	17 aa
SEQ ID NO: 939	trp-1 segment 1	90 nts
SEQ ID NO: 940	Polypeptide encoded by SEQ ID NO: 939	30 aa
SEQ ID NO: 941	trp-1 segment 2	90 nts
SEQ ID NO: 942	Polypeptide encoded by SEQ ID NO: 941	30 aa
SEQ ID NO: 943	trp-1 segment 3	90 nts
SEQ ID NO: 944	Polypeptide encoded by SEQ ID NO: 943	30 aa
SEQ ID NO: 945	trp-1 segment 4	90 nts
SEQ ID NO: 946	Polypeptide encoded by SEQ ID NO: 945	30 aa
SEQ ID NO: 947	trp-1 segment 5	90 nts
SEQ ID NO: 948	Polypeptide encoded by SEQ ID NO: 947	30 aa
SEQ ID NO: 949	trp-1 segment 6	90 nts
SEQ ID NO: 950	Polypeptide encoded by SEQ ID NO: 949	30 aa
SEQ ID NO: 951	trp-1 segment 7	90 nts
SEQ ID NO: 952	Polypeptide encoded by SEQ ID NO: 951	30 aa
SEQ ID NO: 953	trp-1 segment 8	90 nts
SEQ ID NO: 954	Polypeptide encoded by SEQ ID NO: 953	30 aa
SEQ ID NO: 955	trp-1 segment 9	90 nts
SEQ ID NO: 956	Polypeptide encoded by SEQ ID NO: 955	30 aa
SEQ ID NO: 957	trp-1 segment 10	90 nts
SEQ ID NO: 958	Polypeptide encoded by SEQ ID NO: 957	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 959	trp-1 segment 11	90 nts
SEQ ID NO: 960	Polypeptide encoded by SEQ ID NO: 959	30 aa
SEQ ID NO: 961	trp-1 segment 12	90 nts
SEQ ID NO: 962	Polypeptide encoded by SEQ ID NO: 961	30 aa
SEQ ID NO: 963	trp-1 segment 13	90 nts
SEQ ID NO: 964	Polypeptide encoded by SEQ ID NO: 963	30 aa
SEQ ID NO: 965	trp-1 segment 14	90 nts
SEQ ID NO: 966	Polypeptide encoded by SEQ ID NO: 965	30 aa
SEQ ID NO: 967	trp-1 segment 15	90 nts
SEQ ID NO: 968	Polypeptide encoded by SEQ ID NO: 967	30 aa
SEQ ID NO: 969	trp-1 segment 16	81 nts
SEQ ID NO: 970	Polypeptide encoded by SEQ ID NO: 969	27 aa
SEQ ID NO: 971	tyros segment 1	90 nts
SEQ ID NO: 972	Polypeptide encoded by SEQ ID NO: 971	30 aa
SEQ ID NO: 973	tyros segment 2	90 nts
SEQ ID NO: 974	Polypeptide encoded by SEQ ID NO: 973	30 aa
SEQ ID NO: 975	tyros segment 3	90 nts
SEQ ID NO: 976	Polypeptide encoded by SEQ ID NO: 975	30 aa
SEQ ID NO: 977	tyros segment 4	90 nts
SEQ ID NO: 978	Polypeptide encoded by SEQ ID NO: 977	30 aa
SEQ ID NO: 979	tyros segment 5	90 nts
SEQ ID NO: 980	Polypeptide encoded by SEQ ID NO: 979	30 aa
SEQ ID NO: 981	tyros segment 6	90 nts
SEQ ID NO: 982	Polypeptide encoded by SEQ ID NO: 981	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 983	tyros segment 7	90 nts
SEQ ID NO: 984	Polypeptide encoded by SEQ ID NO: 983	30 aa
SEQ ID NO: 985	tyros segment 8	90 nts
SEQ ID NO: 986	Polypeptide encoded by SEQ ID NO: 985	30 aa
SEQ ID NO: 987	tyros segment 9	90 nts
SEQ ID NO: 988	Polypeptide encoded by SEQ ID NO: 987	30 aa
SEQ ID NO: 989	tyros segment 10	90 nts
SEQ ID NO: 990	Polypeptide encoded by SEQ ID NO: 989	30 aa
SEQ ID NO: 991	tyros segment 11	90 nts
SEQ ID NO: 992	Polypeptide encoded by SEQ ID NO: 991	30 aa
SEQ ID NO: 993	tyros segment 12	90 nts
SEQ ID NO: 994	Polypeptide encoded by SEQ ID NO: 993	30 aa
SEQ ID NO: 995	tyros segment 13	90 nts
SEQ ID NO: 996	Polypeptide encoded by SEQ ID NO: 995	30 aa
SEQ ID NO: 997	tyros segment 14	90 nts
SEQ ID NO: 998	Polypeptide encoded by SEQ ID NO: 997	30 aa
SEQ ID NO: 999	tyros segment 15	90 nts
SEQ ID NO: 1000	Polypeptide encoded by SEQ ID NO: 999	30 aa
SEQ ID NO: 1001	tyros segment 16	90 nts
SEQ ID NO: 1002	Polypeptide encoded by SEQ ID NO: 1001	30 aa
SEQ ID NO: 1003	tyros segment 17	90 nts
SEQ ID NO: 1004	Polypeptide encoded by SEQ ID NO: 1003	30 aa
SEQ ID NO: 1005	tyros segment 18	90 nts
SEQ ID NO: 1006	Polypeptide encoded by SEQ ID NO: 1005	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 1007	tyros segment 19	90 nts
SEQ ID NO: 1008	Polypeptide encoded by SEQ ID NO: 1007	30 aa
SEQ ID NO: 1009	tyros segment 20	90 nts
SEQ ID NO: 1010	Polypeptide encoded by SEQ ID NO: 1009	30 aa
SEQ ID NO: 1011	tyros segment 21	90 nts
SEQ ID NO: 1012	Polypeptide encoded by SEQ ID NO: 1011	30 aa
SEQ ID NO: 1013	tyros segment 22	90 nts
SEQ ID NO: 1014	Polypeptide encoded by SEQ ID NO: 1013	30 aa
SEQ ID NO: 1015	tyros segment 23	90 nts
SEQ ID NO: 1016	Polypeptide encoded by SEQ ID NO: 1015	30 aa
SEQ ID NO: 1017	tyros segment 24	90 nts
SEQ ID NO: 1018	Polypeptide encoded by SEQ ID NO: 1017	30 aa
SEQ ID NO: 1019	tyros segment 25	90 nts
SEQ ID NO: 1020	Polypeptide encoded by SEQ ID NO: 1019	30 aa
SEQ ID NO: 1021	tyros segment 26	90 nts
SEQ ID NO: 1022	Polypeptide encoded by SEQ ID NO: 1021	30 aa
SEQ ID NO: 1023	tyros segment 27	90 nts
SEQ ID NO: 1024	Polypeptide encoded by SEQ ID NO: 1023	30 aa
SEQ ID NO: 1025	tyros segment 28	90 nts
SEQ ID NO: 1026	Polypeptide encoded by SEQ ID NO: 1025	30 aa
SEQ ID NO: 1027	tyros segment 29	90 nts
SEQ ID NO: 1028	Polypeptide encoded by SEQ ID NO: 1027	30 aa
SEQ ID NO: 1029	tyros segment 30	90 nts
SEQ ID NO: 1030	Polypeptide encoded by SEQ ID NO: 1029	30 aa

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SEQUENCE ID NO.	SEQUENCE	LENGTH
SEQ ID NO: 1031	tyros segment 31	90 nts
SEQ ID NO: 1032	Polypeptide encoded by SEQ ID NO: 1031	30 aa
SEQ ID NO: 1033	tyros segment 32	90 nts
SEQ ID NO: 1034	Polypeptide encoded by SEQ ID NO: 1033	30 aa
SEQ ID NO: 1035	tyros segment 33	90 nts
SEQ ID NO: 1036	Polypeptide encoded by SEQ ID NO: 1035	30 aa
SEQ ID NO: 1037	tyros segment 34	90 nts
SEQ ID NO: 1038	Polypeptide encoded by SEQ ID NO: 1037	30 aa
SEQ ID NO: 1039	tyros segment 35	69 nts
SEQ ID NO: 1040	Polypeptide encoded by SEQ ID NO: 1039	23 aa
SEQ ID NO: 1041	trp2 segment 1	90 nts
SEQ ID NO: 1042	Polypeptide encoded by SEQ ID NO: 1041	30 aa
SEQ ID NO: 1043	trp2 segment 2	90 nts
SEQ ID NO: 1044	Polypeptide encoded by SEQ ID NO: 1043	30 aa
SEQ ID NO: 1045	trp2 segment 3	90 nts
SEQ ID NO: 1046	Polypeptide encoded by SEQ ID NO: 1045	30 aa
SEQ ID NO: 1047	trp2 segment 4	90 nts
SEQ ID NO: 1048	Polypeptide encoded by SEQ ID NO: 1047	30 aa
SEQ ID NO: 1049	trp2 segment 5	90 nts
SEQ ID NO: 1050	Polypeptide encoded by SEQ ID NO: 1049	30 aa
SEQ ID NO: 1051	trp2 segment 6	90 nts
SEQ ID NO: 1052	Polypeptide encoded by SEQ ID NO: 1051	30 aa
SEQ ID NO: 1053	trp2 segment 7	90 nts
SEQ ID NO: 1054	Polypeptide encoded by SEQ ID NO: 1053	30 aa

SEQUENCE NO.	SEQUENCE	LENGTH
SEQ ID NO: 1055	trp2 segment 8	90 nts
SEQ ID NO: 1056	Polypeptide encoded by SEQ ID NO: 1055	30 aa
SEQ ID NO: 1057	trp2 segment 9	90 nts
SEQ ID NO: 1058	Polypeptide encoded by SEQ ID NO: 1057	30 aa
SEQ ID NO: 1059	trp2 segment 10	90 nts
SEQ ID NO: 1060	Polypeptide encoded by SEQ ID NO: 1059	30 aa
SEQ ID NO: 1061	trp2 segment 11	90 nts
SEQ ID NO: 1062	Polypeptide encoded by SEQ ID NO: 1061	30 aa
SEQ ID NO: 1063	trp2 segment 12	90 nts
SEQ ID NO: 1064	Polypeptide encoded by SEQ ID NO: 1063	30 aa
SEQ ID NO: 1065	trp2 segment 13	90 nts
SEQ ID NO: 1066	Polypeptide encoded by SEQ ID NO: 1065	30 aa
SEQ ID NO: 1067	trp2 segment 14	90 nts
SEQ ID NO: 1068	Polypeptide encoded by SEQ ID NO: 1067	30 aa
SEQ ID NO: 1069	trp2 segment 15	90 nts
SEQ ID NO: 1070	Polypeptide encoded by SEQ ID NO: 1069	30 aa
SEQ ID NO: 1071	trp2 segment 16	90 nts
SEQ ID NO: 1072	Polypeptide encoded by SEQ ID NO: 1071	30 aa
SEQ ID NO: 1073	trp2 segment 17	90 nts
SEQ ID NO: 1074	Polypeptide encoded by SEQ ID NO: 1073	30 aa
SEQ ID NO: 1075	trp2 segment 18	90 nts
SEQ ID NO: 1076	Polypeptide encoded by SEQ ID NO: 1075	30 aa
SEQ ID NO: 1077	trp2 segment 19	90 nts
SEQ ID NO: 1078	Polypeptide encoded by SEQ ID NO: 1077	30 aa

SEQUENCE ID NO.	SEQUENCE	LENGTH
SEQ ID NO: 1079	trp2 segment 20	90 nts
SEQ ID NO: 1080	Polypeptide encoded by SEQ ID NO: 1079	30 aa
SEQ ID NO: 1081	trp2 segment 21	90 nts
SEQ ID NO: 1082	Polypeptide encoded by SEQ ID NO: 1081	30 aa
SEQ ID NO: 1083	trp2 segment 22	90 nts
SEQ ID NO: 1084	Polypeptide encoded by SEQ ID NO: 1083	30 aa
SEQ ID NO: 1085	trp2 segment 23	90 nts
SEQ ID NO: 1086	Polypeptide encoded by SEQ ID NO: 1085	30 aa
SEQ ID NO: 1087	trp2 segment 24	90 nts
SEQ ID NO: 1088	Polypeptide encoded by SEQ ID NO: 1087	30 aa
SEQ ID NO: 1089	trp2 segment 25	90 nts
SEQ ID NO: 1090	Polypeptide encoded by SEQ ID NO: 1089	30 aa
SEQ ID NO: 1091	trp2 segment 26	90 nts
SEQ ID NO: 1092	Polypeptide encoded by SEQ ID NO: 1091	30 aa
SEQ ID NO: 1093	trp2 segment 27	90 nts
SEQ ID NO: 1094	Polypeptide encoded by SEQ ID NO: 1093	30 aa
SEQ ID NO: 1095	trp2 segment 28	90 nts
SEQ ID NO: 1096	Polypeptide encoded by SEQ ID NO: 1095	30 aa
SEQ ID NO: 1097	trp2 segment 29	90 nts
SEQ ID NO: 1098	Polypeptide encoded by SEQ ID NO: 1097	30 aa
SEQ ID NO: 1099	trp2 segment 30	90 nts
SEQ ID NO: 1100	Polypeptide encoded by SEQ ID NO: 1099	30 aa
SEQ ID NO: 1101	trp2 segment 31	90 nts
SEQ ID NO: 1102	Polypeptide encoded by SEQ ID NO: 1101	30 aa

SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 1103	trp2 segment 32	90 nts
SEQ ID NO: 1104	Polypeptide encoded by SEQ ID NO: 1103	30 aa
SEQ ID NO: 1105	trp2 segment 33	90 nts
SEQ ID NO: 1106	Polypeptide encoded by SEQ ID NO: 1105	30 aa
SEQ ID NO: 1107	trp2 segment 34	84 nts
SEQ ID NO: 1108	Polypeptide encoded by SEQ ID NO: 1107	28 aa
SEQ ID NO: 1109	MC1R segment 1	90 nts
SEQ ID NO: 1110	Polypeptide encoded by SEQ ID NO: 1109	30 aa
SEQ ID NO: 1111	MC1R segment 2	90 nts
SEQ ID NO: 1112	Polypeptide encoded by SEQ ID NO: 1111	30 aa
SEQ ID NO: 1113	MC1R segment 3	90 nts
SEQ ID NO: 1114	Polypeptide encoded by SEQ ID NO: 1113	30 aa
SEQ ID NO: 1115	MC1R segment 4	90 nts
SEQ ID NO: 1116	Polypeptide encoded by SEQ ID NO: 1115	30 aa
SEQ ID NO: 1117	MC1R segment 5	90 nts
SEQ ID NO: 1118	Polypeptide encoded by SEQ ID NO: 1117	30 aa
SEQ ID NO: 1119	MC1R segment 6	90 nts
SEQ ID NO: 1120	Polypeptide encoded by SEQ ID NO: 1119	30 aa
SEQ ID NO: 1121	MC1R segment 7	90 nts
SEQ ID NO: 1122	Polypeptide encoded by SEQ ID NO: 1121	30 aa
SEQ ID NO: 1123	MC1R segment 8	90 nts
SEQ ID NO: 1124	Polypeptide encoded by SEQ ID NO: 1123	30 aa
SEQ ID NO: 1125	MC1R segment 9	90 nts
SEQ ID NO: 1126	Polypeptide encoded by SEQ ID NO: 1125	30 aa

SEQUENCE NO.	SEQUENCE	LENGTH
SEQ ID NO: 1127	MC1R segment 10	90 nts
SEQ ID NO: 1128	Polypeptide encoded by SEQ ID NO: 1127	30 aa
SEQ ID NO: 1129	MC1R segment 11	90 nts
SEQ ID NO: 1130	Polypeptide encoded by SEQ ID NO: 1129	30 aa
SEQ ID NO: 1131	MC1R segment 12	90 nts
SEQ ID NO: 1132	Polypeptide encoded by SEQ ID NO: 1131	30 aa
SEQ ID NO: 1133	MC1R segment 13	90 nts
SEQ ID NO: 1134	Polypeptide encoded by SEQ ID NO: 1133	30 aa
SEQ ID NO: 1135	MC1R segment 14	90 nts
SEQ ID NO: 1136	Polypeptide encoded by SEQ ID NO: 1135	30 aa
SEQ ID NO: 1137	MC1R segment 15	90 nts
SEQ ID NO: 1138	Polypeptide encoded by SEQ ID NO: 1137	30 aa
SEQ ID NO: 1139	MC1R segment 16	90 nts
SEQ ID NO: 1140	Polypeptide encoded by SEQ ID NO: 1139	30 aa
SEQ ID NO: 1141	MC1R segment 17	90 nts
SEQ ID NO: 1142	Polypeptide encoded by SEQ ID NO: 1141	30 aa
SEQ ID NO: 1143	MC1R segment 18	90 nts
SEQ ID NO: 1144	Polypeptide encoded by SEQ ID NO: 1143	30 aa
SEQ ID NO: 1145	MC1R segment 19	90 nts
SEQ ID NO: 1146	Polypeptide encoded by SEQ ID NO: 1145	30 aa
SEQ ID NO: 1147	MC1R segment 20	90 nts
SEQ ID NO: 1148	Polypeptide encoded by SEQ ID NO: 1147	30 aa
SEQ ID NO: 1149	MC1R segment 21	63 nts
SEQ ID NO: 1150	Polypeptide encoded by SEQ ID NO: 1149	21 aa

SEQUENCE NO.	SEQUENCE	LENGTH
SEQ ID NO: 1151	MUC1F segment 1	90 nts
SEQ ID NO: 1152	Polypeptide encoded by SEQ ID NO: 1151	30 aa
SEQ ID NO: 1153	MUC1F segment 2	90 nts
SEQ ID NO: 1154	Polypeptide encoded by SEQ ID NO: 1153	30 aa
SEQ ID NO: 1155	MUC1F segment 3	90 nts
SEQ ID NO: 1156	Polypeptide encoded by SEQ ID NO: 1155	30 aa
SEQ ID NO: 1157	MUC1F segment 4	90 nts
SEQ ID NO: 1158	Polypeptide encoded by SEQ ID NO: 1157	30 aa
SEQ ID NO: 1159	MUC1F segment 5	90 nts
SEQ ID NO: 1160	Polypeptide encoded by SEQ ID NO: 1159	30 aa
SEQ ID NO: 1161	MUC1F segment 6	90 nts
SEQ ID NO: 1162	Polypeptide encoded by SEQ ID NO: 1161	30 aa
SEQ ID NO: 1163	MUC1F segment 7	90 nts
SEQ ID NO: 1164	Polypeptide encoded by SEQ ID NO: 1163	30 aa
SEQ ID NO: 1165	MUC1F segment 8	72 nts
SEQ ID NO: 1166	Polypeptide encoded by SEQ ID NO: 1165	24 aa
SEQ ID NO: 1167	MUC1R segment 1	90 nts
SEQ ID NO: 1168	Polypeptide encoded by SEQ ID NO: 1167	30 aa
SEQ ID NO: 1169	MUC1R segment 2	90 nts
SEQ ID NO: 1170	Polypeptide encoded by SEQ ID NO: 1169	30 aa
SEQ ID NO: 1171	MUC1R segment 3	90 nts
SEQ ID NO: 1172	Polypeptide encoded by SEQ ID NO: 1171	30 aa
SEQ ID NO: 1173	MUC1R segment 4	90 nts
SEQ ID NO: 1174	Polypeptide encoded by SEQ ID NO: 1173	30 aa

SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 1175	MUC1R segment 5	90 nts
SEQ ID NO: 1176	Polypeptide encoded by SEQ ID NO: 1175	30 aa
SEQ ID NO: 1177	MUC1R segment 6	90 nts
SEQ ID NO: 1178	Polypeptide encoded by SEQ ID NO: 1177	30 aa
SEQ ID NO: 1179	MUC1R segment 7	90 nts
SEQ ID NO: 1180	Polypeptide encoded by SEQ ID NO: 1179	30 aa
SEQ ID NO: 1181	MUC1R segment 8	90 nts
SEQ ID NO: 1182	Polypeptide encoded by SEQ ID NO: 1181	30 aa
SEQ ID NO: 1183	MUC1R segment 9	90 nts
SEQ ID NO: 1184	Polypeptide encoded by SEQ ID NO: 1183	30 aa
SEQ ID NO: 1185	MUC1R segment 10	90 nts
SEQ ID NO: 1186	Polypeptide encoded by SEQ ID NO: 1185	30 aa
SEQ ID NO: 1187	MUC1R segment 11	90 nts
SEQ ID NO: 1188	Polypeptide encoded by SEQ ID NO: 1187	30 aa
SEQ ID NO: 1189	MUC1R segment 12	90 nts
SEQ ID NO: 1190	Polypeptide encoded by SEQ ID NO: 1189	30 aa
SEQ ID NO: 1191	MUC1R segment 13	90 nts
SEQ ID NO: 1192	Polypeptide encoded by SEQ ID NO: 1191	30 aa
SEQ ID NO: 1193	MUC1R segment 14	90 nts
SEQ ID NO: 1194	Polypeptide encoded by SEQ ID NO: 1193	30 aa
SEQ ID NO: 1195	MUC1R segment 15	90 nts
SEQ ID NO: 1196	Polypeptide encoded by SEQ ID NO: 1195	30 aa
SEQ ID NO: 1197	MUC1R segment 16	90 nts
SEQ ID NO: 1198	Polypeptide encoded by SEQ ID NO: 1197	30 aa

SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 1199	MUC1R segment 17	90 nts
SEQ ID NO: 1200	Polypeptide encoded by SEQ ID NO: 1199	30 aa
SEQ ID NO: 1201	MUC1R segment 18	90 nts
SEQ ID NO: 1202	Polypeptide encoded by SEQ ID NO: 1201	30 aa
SEQ ID NO: 1203	MUC1R segment 19	90 nts
SEQ ID NO: 1204	Polypeptide encoded by SEQ ID NO: 1203	30 aa
SEQ ID NO: 1205	MUC1R segment 20	90 nts
SEQ ID NO: 1206	Polypeptide encoded by SEQ ID NO: 1205	30 aa
SEQ ID NO: 1207	MUC1R segment 21	48 nts
SEQ ID NO: 1208	Polypeptide encoded by SEQ ID NO: 1207	16 aa
SEQ ID NO: 1209	Differentiation Savine	16638 nts
SEQ ID NO: 1210	Polypeptide encoded by SEQ ID NO: 1209	5546 aa
SEQ ID NO: 1211	BAGE segment 1	90 nts
SEQ ID NO: 1212	Polypeptide encoded by SEQ ID NO: 1211	30 aa
SEQ ID NO: 1213	BAGE segment 2	90 nts
SEQ ID NO: 1214	Polypeptide encoded by SEQ ID NO: 1213	30 aa
SEQ ID NO: 1215	BAGE segment 3	51 nts
SEQ ID NO: 1216	Polypeptide encoded by SEQ ID NO: 1215	17 aa
SEQ ID NO: 1217	GAGE-1 segment 1	90 nts
SEQ ID NO: 1218	Polypeptide encoded by SEQ ID NO: 1217	30 aa
SEQ ID NO: 1219	GAGE-1 segment 2	90 nts
SEQ ID NO: 1220	Polypeptide encoded by SEQ ID NO: 1219	30 aa
SEQ ID NO: 1221	GAGE-1 segment 3	90 nts
SEQ ID NO: 1222	Polypeptide encoded by SEQ ID NO: 1221	30 aa

SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 1223	GAGE-1 segment 4	90 nts
SEQ ID NO: 1224	Polypeptide encoded by SEQ ID NO: 1223	30 aa
SEQ ID NO: 1225	GAGE-1 segment 5	90 nts
SEQ ID NO: 1226	Polypeptide encoded by SEQ ID NO: 1225	30 aa
SEQ ID NO: 1227	GAGE-1 segment 6	90 nts
SEQ ID NO: 1228	Polypeptide encoded by SEQ ID NO: 1227	30 aa
SEQ ID NO: 1229	GAGE-1 segment 7	90 nts
SEQ ID NO: 1230	Polypeptide encoded by SEQ ID NO: 1229	30 aa
SEQ ID NO: 1231	GAGE-1 segment 8	90 nts
SEQ ID NO: 1232	Polypeptide encoded by SEQ ID NO: 1231	30 aa
SEQ ID NO: 1233	GAGE-1 segment 9	66 nts
SEQ ID NO: 1234	Polypeptide encoded by SEQ ID NO: 1233	22 aa
SEQ ID NO: 1235	gp100ln4 segment 1	90 nts
SEQ ID NO: 1236	Polypeptide encoded by SEQ ID NO: 1235	30 aa
SEQ ID NO: 1237	gp100ln4 segment 2	90 nts
SEQ ID NO: 1238	Polypeptide encoded by SEQ ID NO: 1237	30 aa
SEQ ID NO: 1239	gp100ln4 segment 3	75 nts
SEQ ID NO: 1240	Polypeptide encoded by SEQ ID NO: 1239	25 aa
SEQ ID NO: 1241	MAGE-1 segment 1	90 nts
SEQ ID NO: 1242	Polypeptide encoded by SEQ ID NO: 1241	30 aa
SEQ ID NO: 1243	MAGE-1 segment 2	90 nts
SEQ ID NO: 1244	Polypeptide encoded by SEQ ID NO: 1243	30 aa
SEQ ID NO: 1245	MAGE-1 segment 3	90 nts
SEQ ID NO: 1246	Polypeptide encoded by SEQ ID NO: 1245	30 aa

SEQ ID NO: SEQUENCE	SEQUENCE	LENGTH
SEQ ID NO: 1247	MAGE-1 segment 4	90 nts
SEQ ID NO: 1248	Polypeptide encoded by SEQ ID NO: 1247	30 aa
SEQ ID NO: 1249	MAGE-1 segment 5	90 nts
SEQ ID NO: 1250	Polypeptide encoded by SEQ ID NO: 1249	30 aa
SEQ ID NO: 1251	MAGE-1 segment 6	90 nts
SEQ ID NO: 1252	Polypeptide encoded by SEQ ID NO: 1251	30 aa
SEQ ID NO: 1253	MAGE-1 segment 7	90 nts
SEQ ID NO: 1254	Polypeptide encoded by SEQ ID NO: 1253	30 aa
SEQ ID NO: 1255	MAGE-1 segment 8	90 nts
SEQ ID NO: 1256	Polypeptide encoded by SEQ ID NO: 1255	30 aa
SEQ ID NO: 1257	MAGE-1 segment 9	90 nts
SEQ ID NO: 1258	Polypeptide encoded by SEQ ID NO: 1257	30 aa
SEQ ID NO: 1259	MAGE-1 segment 10	90 nts
SEQ ID NO: 1260	Polypeptide encoded by SEQ ID NO: 1259	30 aa
SEQ ID NO: 1261	MAGE-1 segment 11	90 nts
SEQ ID NO: 1262	Polypeptide encoded by SEQ ID NO: 1261	30 aa
SEQ ID NO: 1263	MAGE-1 segment 12	90 nts
SEQ ID NO: 1264	Polypeptide encoded by SEQ ID NO: 1263	30 aa
SEQ ID NO: 1265	MAGE-1 segment 13	90 nts
SEQ ID NO: 1266	Polypeptide encoded by SEQ ID NO: 1265	30 aa
SEQ ID NO: 1267	MAGE-1 segment 14	90 nts
SEQ ID NO: 1268	Polypeptide encoded by SEQ ID NO: 1267	30 aa
SEQ ID NO: 1269	MAGE-1 segment 15	90 nts
SEQ ID NO: 1270	Polypeptide encoded by SEQ ID NO: 1269	30 aa

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SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 1271	MAGE-1 segment 16	90 nts
SEQ ID NO: 1272	Polypeptide encoded by SEQ ID NO: 1271	30 aa
SEQ ID NO: 1273	MAGE-1 segment 17	90 nts
SEQ ID NO: 1274	Polypeptide encoded by SEQ ID NO: 1273	30 aa
SEQ ID NO: 1275	MAGE-1 segment 18	90 nts
SEQ ID NO: 1276	Polypeptide encoded by SEQ ID NO: 1275	30 aa
SEQ ID NO: 1277	MAGE-1 segment 19	90 nts
SEQ ID NO: 1278	Polypeptide encoded by SEQ ID NO: 1277	30 aa
SEQ ID NO: 1279	MAGE-1 segment 20	84 nts
SEQ ID NO: 1280	Polypeptide encoded by SEQ ID NO: 1279	28 aa
SEQ ID NO: 1281	MAGE-3 segment 1	90 nts
SEQ ID NO: 1282	Polypeptide encoded by SEQ ID NO: 1281	30 aa
SEQ ID NO: 1283	MAGE-3 segment 2	90 nts
SEQ ID NO: 1284	Polypeptide encoded by SEQ ID NO: 1283	30 aa
SEQ ID NO: 1285	MAGE-3 segment 3	90 nts
SEQ ID NO: 1286	Polypeptide encoded by SEQ ID NO: 1285	30 aa
SEQ ID NO: 1287	MAGE-3 segment 4	90 nts
SEQ ID NO: 1288	Polypeptide encoded by SEQ ID NO: 1287	30 aa
SEQ ID NO: 1289	MAGE-3 segment 5	90 nts
SEQ ID NO: 1290	Polypeptide encoded by SEQ ID NO: 1289	30 aa
SEQ ID NO: 1291	MAGE-3 segment 6	90 nts
SEQ ID NO: 1292	Polypeptide encoded by SEQ ID NO: 1291	30 aa
SEQ ID NO: 1293	MAGE-3 segment 7	90 nts
SEQ ID NO: 1294	Polypeptide encoded by SEQ ID NO: 1293	30 aa

SEQ ID NO NUMBER	NAME	LENGTH
SEQ ID NO: 1295	MAGE-3 segment 8	90 nts
SEQ ID NO: 1296	Polypeptide encoded by SEQ ID NO: 1295	30 aa
SEQ ID NO: 1297	MAGE-3 segment 9	90 nts
SEQ ID NO: 1298	Polypeptide encoded by SEQ ID NO: 1297	30 aa
SEQ ID NO: 1299	MAGE-3 segment 10	90 nts
SEQ ID NO: 1300	Polypeptide encoded by SEQ ID NO: 1299	30 aa
SEQ ID NO: 1301	MAGE-3 segment 11	90 nts
SEQ ID NO: 1302	Polypeptide encoded by SEQ ID NO: 1301	30 aa
SEQ ID NO: 1303	MAGE-3 segment 12	90 nts
SEQ ID NO: 1304	Polypeptide encoded by SEQ ID NO: 1303	30 aa
SEQ ID NO: 1305	MAGE-3 segment 13	90 nts
SEQ ID NO: 1306	Polypeptide encoded by SEQ ID NO: 1305	30 aa
SEQ ID NO: 1307	MAGE-3 segment 14	90 nts
SEQ ID NO: 1308	Polypeptide encoded by SEQ ID NO: 1307	30 aa
SEQ ID NO: 1309	MAGE-3 segment 15	90 nts
SEQ ID NO: 1310	Polypeptide encoded by SEQ ID NO: 1309	30 aa
SEQ ID NO: 1311	MAGE-3 segment 16	90 nts
SEQ ID NO: 1312	Polypeptide encoded by SEQ ID NO: 1311	30 aa
SEQ ID NO: 1313	MAGE-3 segment 17	90 nts
SEQ ID NO: 1314	Polypeptide encoded by SEQ ID NO: 1313	30 aa
SEQ ID NO: 1315	MAGE-3 segment 18	90 nts
SEQ ID NO: 1316	Polypeptide encoded by SEQ ID NO: 1315	30 aa
SEQ ID NO: 1317	MAGE-3 segment 19	90 nts
SEQ ID NO: 1318	Polypeptide encoded by SEQ ID NO: 1317	30 aa

SEQUENCE ID NO.	SEQUENCE	LENGTH
SEQ ID NO: 1319	MAGE-3 segment 20	90 nts
SEQ ID NO: 1320	Polypeptide encoded by SEQ ID NO: 1319	30 aa
SEQ ID NO: 1321	MAGE-3 segment 21	54 nts
SEQ ID NO: 1322	Polypeptide encoded by SEQ ID NO: 1321	18 aa
SEQ ID NO: 1323	PRAME segment 1	90 nts
SEQ ID NO: 1324	Polypeptide encoded by SEQ ID NO: 1323	30 aa
SEQ ID NO: 1325	PRAME segment 2	90 nts
SEQ ID NO: 1326	Polypeptide encoded by SEQ ID NO: 1325	30 aa
SEQ ID NO: 1327	PRAME segment 3	90 nts
SEQ ID NO: 1328	Polypeptide encoded by SEQ ID NO: 1327	30 aa
SEQ ID NO: 1329	PRAME segment 4	90 nts
SEQ ID NO: 1330	Polypeptide encoded by SEQ ID NO: 1329	30 aa
SEQ ID NO: 1331	PRAME segment 5	90 nts
SEQ ID NO: 1332	Polypeptide encoded by SEQ ID NO: 1331	30 aa
SEQ ID NO: 1333	PRAME segment 6	90 nts
SEQ ID NO: 1334	Polypeptide encoded by SEQ ID NO: 1333	30 aa
SEQ ID NO: 1335	PRAME segment 7	90 nts
SEQ ID NO: 1336	Polypeptide encoded by SEQ ID NO: 1335	30 aa
SEQ ID NO: 1337	PRAME segment 8	90 nts
SEQ ID NO: 1338	Polypeptide encoded by SEQ ID NO: 1337	30 aa
SEQ ID NO: 1339	PRAME segment 9	90 nts
SEQ ID NO: 1340	Polypeptide encoded by SEQ ID NO: 1339	30 aa
SEQ ID NO: 1341	PRAME segment 10	90 nts
SEQ ID NO: 1342	Polypeptide encoded by SEQ ID NO: 1341	30 aa

SEQUENCE NO.	REFERENCE	LENGTH
SEQ ID NO: 1343	PRAME segment 11	90 nts
SEQ ID NO: 1344	Polypeptide encoded by SEQ ID NO: 1343	30 aa
SEQ ID NO: 1345	PRAME segment 12	90 nts
SEQ ID NO: 1346	Polypeptide encoded by SEQ ID NO: 1345	30 aa
SEQ ID NO: 1347	PRAME segment 13	90 nts
SEQ ID NO: 1348	Polypeptide encoded by SEQ ID NO: 1347	30 aa
SEQ ID NO: 1349	PRAME segment 14	90 nts
SEQ ID NO: 1350	Polypeptide encoded by SEQ ID NO: 1349	30 aa
SEQ ID NO: 1351	PRAME segment 15	90 nts
SEQ ID NO: 1352	Polypeptide encoded by SEQ ID NO: 1351	30 aa
SEQ ID NO: 1353	PRAME segment 16	90 nts
SEQ ID NO: 1354	Polypeptide encoded by SEQ ID NO: 1353	30 aa
SEQ ID NO: 1355	PRAME segment 17	90 nts
SEQ ID NO: 1356	Polypeptide encoded by SEQ ID NO: 1355	30 aa
SEQ ID NO: 1357	PRAME segment 18	90 nts
SEQ ID NO: 1358	Polypeptide encoded by SEQ ID NO: 1357	30 aa
SEQ ID NO: 1359	PRAME segment 19	90 nts
SEQ ID NO: 1360	Polypeptide encoded by SEQ ID NO: 1359	30 aa
SEQ ID NO: 1361	PRAME segment 20	90 nts
SEQ ID NO: 1362	Polypeptide encoded by SEQ ID NO: 1361	30 aa
SEQ ID NO: 1363	PRAME segment 21	90 nts
SEQ ID NO: 1364	Polypeptide encoded by SEQ ID NO: 1363	30 aa
SEQ ID NO: 1365	PRAME segment 22	90 nts
SEQ ID NO: 1366	Polypeptide encoded by SEQ ID NO: 1365	30 aa

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SEQUENCE NO.	DESCRIPTION	LENGTH
SEQ ID NO: 1367	PRAME segment 23	90 nts
SEQ ID NO: 1368	Polypeptide encoded by SEQ ID NO: 1367	30 aa
SEQ ID NO: 1369	PRAME segment 24	90 nts
SEQ ID NO: 1370	Polypeptide encoded by SEQ ID NO: 1369	30 aa
SEQ ID NO: 1371	PRAME segment 25	90 nts
SEQ ID NO: 1372	Polypeptide encoded by SEQ ID NO: 1371	30 aa
SEQ ID NO: 1373	PRAME segment 26	90 nts
SEQ ID NO: 1374	Polypeptide encoded by SEQ ID NO: 1373	30 aa
SEQ ID NO: 1375	PRAME segment 27	90 nts
SEQ ID NO: 1376	Polypeptide encoded by SEQ ID NO: 1375	30 aa
SEQ ID NO: 1377	PRAME segment 28	90 nts
SEQ ID NO: 1378	Polypeptide encoded by SEQ ID NO: 1377	30 aa
SEQ ID NO: 1379	PRAME segment 29	90 nts
SEQ ID NO: 1380	Polypeptide encoded by SEQ ID NO: 1379	30 aa
SEQ ID NO: 1381	PRAME segment 30	90 nts
SEQ ID NO: 1382	Polypeptide encoded by SEQ ID NO: 1381	30 aa
SEQ ID NO: 1383	PRAME segment 31	90 nts
SEQ ID NO: 1384	Polypeptide encoded by SEQ ID NO: 1383	30 aa
SEQ ID NO: 1385	PRAME segment 32	90 nts
SEQ ID NO: 1386	Polypeptide encoded by SEQ ID NO: 1385	30 aa
SEQ ID NO: 1387	PRAME segment 33	90 nts
SEQ ID NO: 1388	Polypeptide encoded by SEQ ID NO: 1387	30 aa
SEQ ID NO: 1389	PRAME segment 34	54 nts
SEQ ID NO: 1390	Polypeptide encoded by SEQ ID NO: 1389	18 aa

SEQ ID NO	DESCRIPTION	LENGTH
SEQ ID NO: 1391	TRP2IN2 segment 1	90 nts
SEQ ID NO: 1392	Polypeptide encoded by SEQ ID NO: 1391	30 aa
SEQ ID NO: 1393	TRP2IN2 segment 2	90 nts
SEQ ID NO: 1394	Polypeptide encoded by SEQ ID NO: 1393	30 aa
SEQ ID NO: 1395	TRP2IN2 segment 3	84 nts
SEQ ID NO: 1396	Polypeptide encoded by SEQ ID NO: 1395	28 aa
SEQ ID NO: 1397	NYNSO1a segment 1	90 nts
SEQ ID NO: 1398	Polypeptide encoded by SEQ ID NO: 1397	30 aa
SEQ ID NO: 1399	NYNSO1a segment 2	90 nts
SEQ ID NO: 1400	Polypeptide encoded by SEQ ID NO: 1399	30 aa
SEQ ID NO: 1401	NYNSO1a segment 3	90 nts
SEQ ID NO: 1402	Polypeptide encoded by SEQ ID NO: 1401	30 aa
SEQ ID NO: 1403	NYNSO1a segment 4	90 nts
SEQ ID NO: 1404	Polypeptide encoded by SEQ ID NO: 1403	30 aa
SEQ ID NO: 1405	NYNSO1a segment 5	90 nts
SEQ ID NO: 1406	Polypeptide encoded by SEQ ID NO: 1405	30 aa
SEQ ID NO: 1407	NYNSO1a segment 6	90 nts
SEQ ID NO: 1408	Polypeptide encoded by SEQ ID NO: 1407	30 aa
SEQ ID NO: 1409	NYNSO1a segment 7	90 nts
SEQ ID NO: 1410	Polypeptide encoded by SEQ ID NO: 1409	30 aa
SEQ ID NO: 1411	NYNSO1a segment 8	90 nts
SEQ ID NO: 1412	Polypeptide encoded by SEQ ID NO: 1411	30 aa
SEQ ID NO: 1413	NYNSO1a segment 9	90 nts
SEQ ID NO: 1414	Polypeptide encoded by SEQ ID NO: 1413	30 aa

SEQUENCE ID NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 1415	NYNSO1a segment 10	90 nts
SEQ ID NO: 1416	Polypeptide encoded by SEQ ID NO: 1415	30 aa
SEQ ID NO: 1417	NYNSO1a segment 11	90 nts
SEQ ID NO: 1418	Polypeptide encoded by SEQ ID NO: 1417	30 aa
SEQ ID NO: 1419	NYNSO1a segment 12	57 nts
SEQ ID NO: 1420	Polypeptide encoded by SEQ ID NO: 1419	19 aa
SEQ ID NO: 1421	NYNSO1b segment 1	90 nts
SEQ ID NO: 1422	Polypeptide encoded by SEQ ID NO: 1421	30 aa
SEQ ID NO: 1423	NYNSO1b segment 2	90 nts
SEQ ID NO: 1424	Polypeptide encoded by SEQ ID NO: 1423	30 aa
SEQ ID NO: 1425	NYNSO1b segment 3	90 nts
SEQ ID NO: 1426	Polypeptide encoded by SEQ ID NO: 1425	30 aa
SEQ ID NO: 1427	NYNSO1b segment 4	51 nts
SEQ ID NO: 1428	Polypeptide encoded by SEQ ID NO: 1427	
SEQ ID NO: 1429	LAGE1 segment 1	90 nts
SEQ ID NO: 1430	Polypeptide encoded by SEQ ID NO: 1429	30 aa
SEQ ID NO: 1431	LAGE1 segment 2	90 nts
SEQ ID NO: 1432	Polypeptide encoded by SEQ ID NO: 1431	30 aa
SEQ ID NO: 1433	LAGE1 segment 3	90 nts
SEQ ID NO: 1434	Polypeptide encoded by SEQ ID NO: 1433	30 aa
SEQ ID NO: 1435	LAGE1 segment 4	90 nts
SEQ ID NO: 1436	Polypeptide encoded by SEQ ID NO: 1435	30 aa
SEQ ID NO: 1437	LAGE1 segment 5	90 nts
SEQ ID NO: 1438	Polypeptide encoded by SEQ ID NO: 1437	30 aa

SEQUENCE NUMBER	SEQUENCE	LENGTH
SEQ ID NO: 1439	LAGE1 segment 6	90 nts
SEQ ID NO: 1440	Polypeptide encoded by SEQ ID NO: 1439	30 aa
SEQ ID NO: 1441	LAGE1 segment 7	90 nts
SEQ ID NO: 1442	Polypeptide encoded by SEQ ID NO: 1441	30 aa
SEQ ID NO: 1443	LAGE1 segment 8	90 nts
SEQ ID NO: 1444	Polypeptide encoded by SEQ ID NO: 1443	30 aa
SEQ ID NO: 1445	LAGE1 segment 9	90 nts
SEQ ID NO: 1446	Polypeptide encoded by SEQ ID NO: 1445	30 aa
SEQ ID NO: 1447	LAGE1 segment 10	90 nts
SEQ ID NO: 1448	Polypeptide encoded by SEQ ID NO: 1447	30 aa
SEQ ID NO: 1449	LAGE1 segment 11	90 nts
SEQ ID NO: 1450	Polypeptide encoded by SEQ ID NO: 1449	30 aa
SEQ ID NO: 1451	LAGE1 segment 12	57 nts
SEQ ID NO: 1452	Polypeptide encoded by SEQ ID NO: 1451	19 aa
SEQ ID NO: 1453	Melanoma cancer specific Savine	10623 nts
SEQ ID NO: 1454	Polypeptide encoded by SEQ ID NO: 1453	3541 aa
SEQ ID NO: 1455	Figure 16 A1S1 99mer	99 nts
SEQ ID NO: 1456	Figure 16 A1S2 100mer	100 nts
SEQ ID NO: 1457	Figure 16 A1S3 100mer	100 nts
SEQ ID NO: 1458	Figure 16 A1S4 100mer	100 nts
SEQ ID NO: 1459	Figure 16 A1S5 100mer	100 nts
SEQ ID NO: 1460	Figure 16 A1S6 99mer	99 nts
SEQ ID NO: 1461	Figure 16 A1S7 97mer	99 nts
SEQ ID NO: 1462	Figure 16 A1S8 100mer	100 nts

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SEQ ID NO	SEQUENCE	LENGTH
SEQ ID NO: 1463	Figure 16 A1S9 100mer	100 nts
SEQ ID NO: 1464	Figure 16 A1S10 75mer	76 nts
SEQ ID NO: 1465	Figure 16 A1F 20mer	20 nts
SEQ ID NO: 1466	Figure 16 A1R 20mer	20 nts
SEQ ID NO: 1467	Amino acid sequence of immunostimulatory domain of an invasin protein from <i>Yersinia</i> spp.	16 aa

DETAILED DESCRIPTION OF THE INVENTION

1. Definitions

The articles "*a*" and "*an*" are used herein to refer to one or to more than one (*i.e.*, to at least one) of the grammatical object of the article. By way of example, "an element"
5 means one element or more than one element.

As used herein, the term "*about*" refers to a quantity, level, value, dimension, size, or amount that varies by as much as 30%, preferably by as much as 20%, and more preferably by as much as 10% to a reference quantity, level, value, dimension, size, or amount.

10 By "*antigen-binding molecule*" is meant a molecule that has binding affinity for a target antigen. It will be understood that this term extends to immunoglobulins, immunoglobulin fragments and non-immunoglobulin derived protein frameworks that exhibit antigen-binding activity.

The term "*clade*" as used herein refers to a hypothetical species of an organism
15 and its descendants or a monophyletic group of organisms. Clades carry a definition, based on ancestry, and a diagnosis, based on synapomorphies. It should be noted that diagnoses of clades could change while definitions do not.

Throughout this specification, unless the context requires otherwise, the words "*comprise*", "*comprises*" and "*comprising*" will be understood to imply the inclusion of a
20 stated step or element or group of steps or elements but not the exclusion of any other step or element or group of steps or elements.

By "*expression vector*" is meant any autonomous genetic element capable of directing the synthesis of a protein encoded by the vector. Such expression vectors are known by practitioners in the art.

25 As used herein, the term "*function*" refers to a biological, enzymatic, or therapeutic function.

"Homology" refers to the percentage number of amino acids that are identical or constitute conservative substitutions as defined in Table B *infra*. Homology may be determined using sequence comparison programs such as GAP (Deveraux *et al.* 1984, *Nucleic Acids Research* 12, 387-395). In this way, sequences of a similar or substantially different length to those cited herein might be compared by insertion of gaps into the alignment, such gaps being determined, for example, by the comparison algorithm used by GAP.

To enhance an immune response ("immunoenhancement"), as is well-known in the art, means to increase an animal's capacity to respond to foreign or disease-specific antigens (*e.g.*, cancer antigens) *i.e.*, those cells primed to attack such antigens are increased in number, activity, and ability to detect and destroy the those antigens. Strength of immune response is measured by standard tests including: direct measurement of peripheral blood lymphocytes by means known to the art; natural killer cell cytotoxicity assays (see, *e.g.*, Provinciali M. *et al* (1992, *J. Immunol. Meth.* 155: 19-24), cell proliferation assays (see, *e.g.*, Vollenweider, I. and Groseurth, P. J. (1992, *J. Immunol. Meth.* 149: 133-135), immunoassays of immune cells and subsets (see, *e.g.*, Loeffler, D. A., *et al.* (1992, *Cytom.* 13: 169-174); Rivoltini, L., *et al.* (1992, *Can. Immunol. Immunother.* 34: 241-251); or skin tests for cell-mediated immunity (see, *e.g.*, Chang, A. E. *et al* (1993, *Cancer Res.* 53: 1043-1050). Any statistically significant increase in strength of immune response as measured by the foregoing tests is considered "enhanced immune response" "immunoenhancement" or "immunopotentialiation" as used herein. Enhanced immune response is also indicated by physical manifestations such as fever and inflammation, as well as healing of systemic and local infections, and reduction of symptoms in disease, *i.e.*, decrease in tumour size, alleviation of symptoms of a disease or condition including, but not restricted to, leprosy, tuberculosis, malaria, naphthous ulcers, herpetic and papillomatous warts, gingivitis, arteriosclerosis, the concomitants of AIDS such as Kaposi's sarcoma, bronchial infections, and the like. Such physical manifestations also define "enhanced immune response" "immunoenhancement" or "immunopotentialiation" as used herein.

Reference herein to "immuno-interactive" includes reference to any interaction, reaction, or other form of association between molecules and in particular where one of the molecules is, or mimics, a component of the immune system.

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By "*isolated*" is meant material that is substantially or essentially free from components that normally accompany it in its native state.

By "*modulating*" is meant increasing or decreasing, either directly or indirectly, an immune response against a target antigen of a member selected from the group
5 consisting of a cancer and an organism, preferably a pathogenic organism.

By "*natural gene*" is meant a gene that naturally encodes a protein.

The term "*natural polypeptide*" as used herein refers to a polypeptide that exists in nature.

By "*obtained from*" is meant that a sample such as, for example, a polynucleotide
10 extract or polypeptide extract is isolated from, or derived from, a particular source of the host. For example, the extract can be obtained from a tissue or a biological fluid isolated directly from the host.

The term "*oligonucleotide*" as used herein refers to a polymer composed of a multiplicity of nucleotide residues (deoxyribonucleotides or ribonucleotides, or related
15 structural variants or synthetic analogues thereof) linked via phosphodiester bonds (or related structural variants or synthetic analogues thereof). Thus, while the term "oligonucleotide" typically refers to a nucleotide polymer in which the nucleotide residues and linkages between them are naturally occurring, it will be understood that the term also includes within its scope various analogues including, but not restricted to, peptide nucleic
20 acids (PNAs), phosphoramidates, phosphorothioates, methyl phosphonates, 2-O-methyl ribonucleic acids, and the like. The exact size of the molecule can vary depending on the particular application. An oligonucleotide is typically rather short in length, generally from about 10 to 30 nucleotide residues, but the term can refer to molecules of any length, although the term "polynucleotide" or "nucleic acid" is typically used for large
25 oligonucleotides.

By "*operably linked*" is meant that transcriptional and translational regulatory polynucleotides are positioned relative to a polypeptide-encoding polynucleotide in such a manner that the polynucleotide is transcribed and the polypeptide is translated.

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The term "*parent polypeptide*" as used herein typically refers to a polypeptide encoded by a natural gene. However, it is possible that the parent polypeptide corresponds to a protein that is not naturally-occurring but has been engineered using recombinant techniques. In this instance, a polynucleotide encoding the parent polypeptide may
5 comprise different but synonymous codons relative to a natural gene encoding the same polypeptide. Alternatively, the parent polypeptide may not correspond to a natural polypeptide sequence. For example, the parent polypeptide may comprise one or more consensus sequences common to a plurality of polypeptides.

The term "*patient*" refers to patients of human or other mammal and includes any
10 individual it is desired to examine or treat using the methods of the invention. However, it will be understood that "*patient*" does not imply that symptoms are present. Suitable mammals that fall within the scope of the invention include, but are not restricted to, primates, livestock animals (*e.g.*, sheep, cows, horses, donkeys, pigs), laboratory test animals (*e.g.*, rabbits, mice, rats, guinea pigs, hamsters), companion animals (*e.g.*, cats,
15 dogs) and captive wild animals (*e.g.*, foxes, deer, dingoes).

By "*pharmaceutically-acceptable carrier*" is meant a solid or liquid filler, diluent or encapsulating substance that can be safely used in topical or systemic administration to a mammal.

"*Polypeptide*", "*peptide*" and "*protein*" are used interchangeably herein to refer to
20 a polymer of amino acid residues and to variants and synthetic analogues of the same. Thus, these terms apply to amino acid polymers in which one or more amino acid residues is a synthetic non-naturally occurring amino acid, such as a chemical analogue of a corresponding naturally occurring amino acid, as well as to naturally-occurring amino acid polymers.

25 The term "*polynucleotide*" or "*nucleic acid*" as used herein designates mRNA, RNA, cRNA, cDNA or DNA. The term typically refers to oligonucleotides greater than 30 nucleotide residues in length.

By "*primer*" is meant an oligonucleotide which, when paired with a strand of DNA, is capable of initiating the synthesis of a primer extension product in the presence of
30 a suitable polymerising agent. The primer is preferably single-stranded for maximum

efficiency in amplification but can alternatively be double-stranded. A primer must be sufficiently long to prime the synthesis of extension products in the presence of the polymerisation agent. The length of the primer depends on many factors, including application, temperature to be employed, template reaction conditions, other reagents, and source of primers. For example, depending on the complexity of the target sequence, the oligonucleotide primer typically contains 15 to 35 or more nucleotide residues, although it can contain fewer nucleotide residues. Primers can be large polynucleotides, such as from about 35 nucleotides to several kilobases or more. Primers can be selected to be "substantially complementary" to the sequence on the template to which it is designed to hybridise and serve as a site for the initiation of synthesis. By "substantially complementary", it is meant that the primer is sufficiently complementary to hybridise with a target polynucleotide. Preferably, the primer contains no mismatches with the template to which it is designed to hybridise but this is not essential. For example, non-complementary nucleotide residues can be attached to the 5' end of the primer, with the remainder of the primer sequence being complementary to the template. Alternatively, non-complementary nucleotide residues or a stretch of non-complementary nucleotide residues can be interspersed into a primer, provided that the primer sequence has sufficient complementarity with the sequence of the template to hybridise therewith and thereby form a template for synthesis of the extension product of the primer.

"Probe" refers to a molecule that binds to a specific sequence or sub-sequence or other moiety of another molecule. Unless otherwise indicated, the term "probe" typically refers to a polynucleotide probe that binds to another polynucleotide, often called the "target polynucleotide", through complementary base pairing. Probes can bind target polynucleotides lacking complete sequence complementarity with the probe, depending on the stringency of the hybridisation conditions. Probes can be labelled directly or indirectly.

By "*recombinant polypeptide*" is meant a polypeptide made using recombinant techniques, *i.e.*, through the expression of a recombinant or synthetic polynucleotide.

Terms used to describe sequence relationships between two or more polynucleotides or polypeptides include "reference sequence", "comparison window", "sequence identity", "percentage of sequence identity" and "substantial identity". A "reference sequence" is at least 12 but frequently 15 to 18 and often at least 25 monomer

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units, inclusive of nucleotides and amino acid residues, in length. Because two polynucleotides may each comprise (1) a sequence (*i.e.*, only a portion of the complete polynucleotide sequence) that is similar between the two polynucleotides, and (2) a sequence that is divergent between the two polynucleotides, sequence comparisons between two (or more) polynucleotides are typically performed by comparing sequences of the two polynucleotides over a "comparison window" to identify and compare local regions of sequence similarity. A "comparison window" refers to a conceptual segment of at least 50 contiguous positions, usually about 50 to about 100, more usually about 100 to about 150 in which a sequence is compared to a reference sequence of the same number of contiguous positions after the two sequences are optimally aligned. The comparison window may comprise additions or deletions (*i.e.*, gaps) of about 20% or less as compared to the reference sequence (which does not comprise additions or deletions) for optimal alignment of the two sequences. Optimal alignment of sequences for aligning a comparison window may be conducted by computerised implementations of algorithms (GAP, BESTFIT, FASTA, and TFASTA in the Wisconsin Genetics Software Package Release 7.0, Genetics Computer Group, 575 Science Drive Madison, WI, USA) or by inspection and the best alignment (*i.e.*, resulting in the highest percentage homology over the comparison window) generated by any of the various methods selected. Reference also may be made to the BLAST family of programs as for example disclosed by Altschul *et al.*, 1997, *Nucl. Acids Res.* 25:3389. A detailed discussion of sequence analysis can be found in Unit 19.3 of Ausubel *et al.*, "Current Protocols in Molecular Biology", John Wiley & Sons Inc, 1994-1998, Chapter 15.

The term "sequence identity" as used herein refers to the extent that sequences are identical on a nucleotide-by-nucleotide basis or an amino acid-by-amino acid basis over a window of comparison. Thus, a "percentage of sequence identity" is calculated by comparing two optimally aligned sequences over the window of comparison, determining the number of positions at which the identical nucleic acid base (*e.g.*, A, T, C, G, I) or the identical amino acid residue (*e.g.*, Ala, Pro, Ser, Thr, Gly, Val, Leu, Ile, Phe, Tyr, Trp, Lys, Arg, His, Asp, Glu, Asn, Gln, Cys and Met) occurs in both sequences to yield the number of matched positions, dividing the number of matched positions by the total number of positions in the window of comparison (*i.e.*, the window size), and multiplying the result by 100 to yield the percentage of sequence identity. For the purposes of the present

invention, "*sequence identity*" will be understood to mean the "match percentage" calculated by the DNASIS computer program (Version 2.5 for windows; available from Hitachi Software engineering Co., Ltd., South San Francisco, California, USA) using standard defaults as used in the reference manual accompanying the software.

5 The term "*synthetic polynucleotide*" as used herein refers to a polynucleotide formed *in vitro* by the manipulation of a polynucleotide into a form not normally found in nature. For example, the synthetic polynucleotide can be in the form of an expression vector. Generally, such expression vectors include transcriptional and translational regulatory polynucleotide operably linked to the polynucleotide.

10 The term "*synonymous codon*" as used herein refers to a codon having a different nucleotide sequence than another codon but encoding the same amino acid as that other codon.

By "*translational efficiency*" is meant the efficiency of a cell's protein synthesis machinery to incorporate the amino acid encoded by a codon into a nascent polypeptide chain. This efficiency can be evidenced, for example, by the rate at which the cell is able to synthesise the polypeptide from an RNA template comprising the codon, or by the amount of the polypeptide synthesised from such a template.

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By "*vector*" is meant a polynucleotide molecule, preferably a DNA molecule derived, for example, from a plasmid, bacteriophage, yeast or virus, into which a polynucleotide can be inserted or cloned. A vector preferably contains one or more unique restriction sites and can be capable of autonomous replication in a defined host cell including a target cell or tissue or a progenitor cell or tissue thereof, or be integrable with the genome of the defined host such that the cloned sequence is reproducible. Accordingly, the vector can be an autonomously replicating vector, *i.e.*, a vector that exists as an extrachromosomal entity, the replication of which is independent of chromosomal replication, *e.g.*, a linear or closed circular plasmid, an extrachromosomal element, a minichromosome, or an artificial chromosome. The vector can contain any means for assuring self-replication. Alternatively, the vector can be one which, when introduced into the host cell, is integrated into the genome and replicated together with the chromosome(s) into which it has been integrated. A vector system can comprise a single vector or plasmid, two or more vectors or plasmids, which together contain the total DNA to be introduced

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into the genome of the host cell, or a transposon. The choice of the vector will typically depend on the compatibility of the vector with the host cell into which the vector is to be introduced. In the present case, the vector is preferably a viral or viral-derived vector, which is operably functional in animal and preferably mammalian cells. Such vector may
5 be derived from a poxvirus, an adenovirus or yeast. The vector can also include a selection marker such as an antibiotic resistance gene that can be used for selection of suitable transformants. Examples of such resistance genes are known to those of skill in the art and include the *nptII* gene that confers resistance to the antibiotics kanamycin and G418 (Geneticin®) and the *hph* gene which confers resistance to the antibiotic hygromycin B.

2. *Synthetic polypeptides*

The inventors have surprisingly discovered that the structure of a parent polypeptide can be disrupted sufficiently to impede, abrogate or otherwise alter at least one function of the parent polypeptide, while simultaneously minimising the destruction of potentially useful epitopes that are present in the parent polypeptide, by fusing, coupling or otherwise linking together different segments of the parent polypeptide in a different relationship relative to their linkage in the parent polypeptide. As a result of this change in relationship, the sequence of the linked segments in the resulting synthetic polypeptide is different to a sequence contained within the parent polypeptide. The synthetic polypeptides of the invention are useful as immunopotentiating agents, and are referred to elsewhere in the specification as scrambled antigen vaccines, super attenuated vaccines or "*Savines*".

Thus, the invention broadly resides in a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein said segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide.

It is preferable but not essential that the segments in said synthetic polypeptide are linked sequentially in a different order or arrangement relative to that of corresponding segments in said at least one parent polypeptide. For example, in the case of a parent polypeptide that comprises three contiguous or overlapping segments A-B-C-D, these segments may be linked in 23 other possible orders to form a synthetic polypeptide. These orders may be selected from the group consisting of: A-B-D-C, A-C-B-D, A-C-D-B, A-D-B-C, A-D-C-B, B-A-C-D, B-A-D-C, B-C-A-D, B-C-D-A, B-D-A-C, B-D-C-A, C-A-B-D, C-A-D-B, C-B-A-D, C-B-D-A, C-D-A-B, C-D-B-A, D-A-B-C, D-A-C-B, D-B-A-C, D-B-C-A, D-C-A-B, and D-C-B-A. Although the rearrangement of the segments is preferably random, it is especially preferable to exclude or otherwise minimise rearrangements that result in complete or partial reassembly of the parent sequence (*e.g.*, ADBC, BACD, DABC). It will be appreciated, however, that the probability of such complete or partial reassembly diminishes as the number of segments for rearrangement increases.

The order of the segments is suitably shuffled, reordered or otherwise rearranged relative to the order in which they exist in the parent polypeptide so that the structure of the polypeptide is disrupted sufficiently to impede, abrogate or otherwise alter at least one

function associated with the parent polypeptide. Preferably, the segments of the parent polypeptide are randomly rearranged in the synthetic polypeptide.

The parent polypeptide is suitably a polypeptide that is associated with a disease or condition. For example, the parent polypeptide may be a polypeptide expressed by a pathogenic organism or a cancer. Alternatively, the parent polypeptide can be a self peptide related to an autoimmune disease including, but are not limited to, diseases such as diabetes (*e.g.*, juvenile diabetes), multiple sclerosis, rheumatoid arthritis, myasthenia gravis, atopic dermatitis, and psoriasis and ankylosing spondylitis. Accordingly, the synthetic molecules of the present invention may also have utility for the induction of tolerance in a subject afflicted with an autoimmune disease or condition or with an allergy or other condition to which tolerance is desired. For example tolerance may be induced by contacting an immature dendritic cell of the individual to be treated with a synthetic polypeptide of the invention or by expressing in an immature dendritic cell a synthetic polynucleotide of the invention. Tolerance may also be induced against antigens causing allergic responses (*e.g.*, asthma, hay fever). In this case, the parent polypeptide is suitably an allergenic protein including, but not restricted to, house-dust-mite allergenic proteins as for example described by Thomas and Smith (1998, *Allergy*, 53(9): 821-832).

The pathogenic organism includes, but is not restricted to, yeast, a virus, a bacterium, and a parasite. Any natural host of the pathogenic organism is contemplated by the present invention and includes, but is not limited to, mammals, avians and fish. In a preferred embodiment, the pathogenic organism is a virus, which may be an RNA virus or a DNA virus. Preferably, the RNA virus is Human Immunodeficiency Virus (HIV), Poliovirus, and Influenza virus, Rous sarcoma virus, or a Flavivirus such as Japanese encephalitis virus. In a preferred embodiment, the RNA virus is a Hepatitis virus including, but not limited to, Hepatitis strains A, B and C. Suitably, the DNA virus is a Herpesvirus including, but not limited to, Herpes simplex virus, Epstein-Barr virus, Cytomegalovirus and Parvovirus. In a preferred embodiment, the virus is HIV and the parent polypeptide is suitably selected from env, gag, pol, vif, vpr, tat, rev, vpu and nef, or combination thereof. In an alternate preferred embodiment, the virus is Hepatitis C1a virus and the parent polypeptide is the Hepatitis C1a virus polyprotein.

In another embodiment, the pathogenic organism is a bacterium, which includes, but is not restricted to, *Neisseria* species, *Meningococcal* species, *Haemophilus* species, *Salmonella* species, *Streptococcal* species, *Legionella* species and *Mycobacterium* species.

In yet another embodiment, the pathogenic organism is a parasite, which includes,
5 but is not restricted to, *Plasmodium* species, *Schistosoma* species, *Leishmania* species, *Trypanosoma* species, *Toxoplasma* species and *Giardia* species.

Any cancer or tumour is contemplated by the present invention. For example, the cancer or tumour includes, but is not restricted to, melanoma, lung cancer, breast cancer, cervical cancer, prostate cancer, colon cancer, pancreatic cancer, stomach cancer, bladder
10 cancer, kidney cancer, post transplant lymphoproliferative disease (PTLD), Hodgkin's Lymphoma and the like. Preferably, the cancer or tumour relates to melanoma. In a preferred embodiment of this type, the parent polypeptide is a melanocyte differentiation antigen which is suitably selected from gp100, MART, TRP-1, Tyros, TRP2, MC1R, MUC1F, MUC1R or a combination thereof. In an alternate preferred embodiment of this
15 type, the parent polypeptide is a melanoma-specific antigen which is suitably selected from BAGE, GAGE-1, gp100In4, MAGE-1, MAGE-3, PRAME, TRP2IN2, NYNSO1a, NYNSO1b, LAGE1 or a combination thereof.

In a preferred embodiment, the segments are selected on the basis of size. A segment according to the invention may be of any suitable size that can be utilised to elicit
20 an immune response against an antigen encoded by the parent polypeptide. A number of factors can influence the choice of segment size. For example, the size of a segment should be preferably chosen such that it includes, or corresponds to the size of, T cell epitopes and their processing requirement. Practitioners in the art will recognise that class I-restricted T cell epitopes can be between 8 and 10 amino acids in length and if placed next to unnatural
25 flanking residues, such epitopes can generally require 2 to 3 natural flanking amino acids to ensure that they are efficiently processed and presented. Class II-restricted T cell epitopes can range between 12 and 25 amino acids in length and may not require natural flanking residues for efficient proteolytic processing although it is believed that natural flanking residues may play a role. Another important feature of class II-restricted epitopes
30 is that they generally contain a core of 9-10 amino acids in the middle which bind specifically to class II MHC molecules with flanking sequences either side of this core

stabilising binding by associating with conserved structures on either side of class II MHC antigens in a sequence independent manner (Brown *et al.*, 1993). Thus the functional region of class II-restricted epitopes is typically less than 15 amino acids long. The size of linear B cell epitopes and the factors effecting their processing, like class II-restricted epitopes, are quite variable although such epitopes are frequently smaller in size than 15 amino acids. From the foregoing, it is preferable, but not essential, that the size of the segment is at least 4 amino acids, preferably at least 7 amino acids, more preferably at least 12 amino acids, more preferably at least 20 amino acids and more preferably at least 30 amino acids. Suitably, the size of the segment is less than 2000 amino acids, more preferably less than 1000 amino acids, more preferably less than 500 amino acids, more preferably less than 200 amino acids, more preferably less than 100 amino acids, more preferably less than 80 amino acids and even more preferably less than 60 amino acids and still even more preferably less than 40 amino acids. In this regard, it is preferable that the size of the segments is as small as possible so that the synthetic polypeptide adopts a functionally different structure relative to the structure of the parent polypeptide. It is also preferable that the size of the segments is large enough to minimise loss of T cell epitopes. In an especially preferred embodiment, the size of the segment is about 30 amino acids.

An optional spacer may be utilised to space adjacent segments relative to each other. Accordingly, an optional spacer may be interposed between some or all of the segments. The spacer suitably alters proteolytic processing and/or presentation of adjacent segment(s). In a preferred embodiment of this type, the spacer promotes or otherwise enhances proteolytic processing and/or presentation of adjacent segment(s). Preferably, the spacer comprises at least one amino acid. The at least one amino acid is suitably a neutral amino acid. The neutral amino acid is preferably alanine. Alternatively, the at least one amino acid is cysteine.

In a preferred embodiment, segments are selected such that they have partial sequence identity or homology with one or more other segments. Suitably, at one or both ends of a respective segment there is comprised at least 4 contiguous amino acids, preferably at least 7 contiguous amino acids, more preferably at least 10 contiguous amino acids, more preferably at least 15 contiguous amino acids and even more preferably at least 20 contiguous amino acids that are identical to, or homologous with, an amino acid sequence contained within one or more other of said segments. Preferably, at the or each

end of a respective segment there is comprised less than 500 contiguous amino acids, more preferably less than 200 contiguous amino acids, more preferably less than 100 contiguous amino acids, more preferably less than 50 contiguous amino acids, more preferably less than 40 contiguous amino acids, and even more preferably less than 30 contiguous amino acids that are identical to, or homologous with, an amino acid sequence contained within one or more other of said segments. Such sequence overlap (also referred to elsewhere in the specification as "*overlapping fragments*" or "*overlapping segments*") is preferable to ensure potential epitopes at segment boundaries are not lost and to ensure that epitopes at or near segment boundaries are processed efficiently if placed beside or near amino acids that inhibit processing. Preferably, the segment size is about twice the size of the overlap.

In a preferred embodiment, when segments have partial sequence homology therebetween, the homologous sequences suitably comprise conserved and/or non-conserved amino acid differences. Exemplary conservative substitutions are listed in the following table.

15 **TABLE B**

<i>Original Residue</i>	<i>Exemplary Substitutions</i>
Ala	Ser
Arg	Lys
Asn	Gln, His
Asp	Glu
Cys	Ser
Gln	Asn
Glu	Asp
Gly	Pro
His	Asn, Gln
Ile	Leu, Val
Leu	Ile, Val

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Original Amino Acid	Example Amino Acids
Lys	Arg, Gln, Glu
Met	Leu, Ile,
Phe	Met, Leu, Tyr
Ser	Thr
Thr	Ser
Trp	Tyr
Tyr	Trp, Phe
Val	Ile, Leu

Conserved or non-conserved differences may correspond to polymorphisms in corresponding parent polypeptides. Polymorphic polypeptides are expressed by various pathogenic organisms and cancers. For example, the polymorphic polypeptides may be expressed by different viral strains or clades or by cancers in different individuals.

Sequence overlap between respective segments is preferable to minimise destruction of any epitope sequences that may result from any shuffling or rearrangement of the segments relative to their existing order in the parent polypeptide. If overlapping segments as described above are employed to form a synthetic polypeptide, it may not be necessary to change the order in which those segments are linked together relative to the order in which corresponding segments are normally present in the parent polypeptide. In this regard, such overlapping segments when linked together in the synthetic polypeptide can adopt a different structure relative to the structure of the parent polypeptide, wherein the different structure does not provide for one or more functions associated with the parent polypeptide. For example, in the case of four segments A-B-C-D each spanning 30 contiguous amino acids of the parent polypeptide and having a 10-amino acid overlapping sequence with one or more adjacent segments, the synthetic polypeptide will have duplicated 10-amino acid sequences bridging segments A-B, B-C and C-D. The presence of these duplicated sequences may be sufficient to render a different structure and to abrogate or alter function relative to the parent polypeptide.

In a preferred embodiment, segment size is about 30 amino acids and sequence overlap at one or both ends of a respective segment is about 15 amino acids. However, it will be understood that other suitable segment sizes and sequence overlap sizes are contemplated by the present invention, which can be readily ascertained by persons of skill
5 in the art.

It is preferable but not necessary to utilise all the segments of the parent polypeptide in the construction of the synthetic polypeptide. Suitably, at least 30%, preferably at least 40%, more preferably at least 50%, even more preferably at least 60%, even more preferably at least 70%, even more preferably at least 80% and still even more
10 preferably at least 90% of the parent polypeptide sequence is used in the construction of the synthetic polypeptide. However, it will be understood that the more sequence information from a parent polypeptide that is utilised to construct the synthetic polypeptide, the greater the population coverage will be of the synthetic polypeptide as an immunogen. Preferably, no sequence information from the parent polypeptide is excluded
15 (e.g., because of an apparent lack of immunological epitopes).

Persons of skill in the art will appreciate that when preparing a synthetic polypeptide against a pathogenic organism (e.g., a virus) or a cancer, it may be preferable to use sequence information from a plurality of different polypeptides expressed by the organism or the cancer. Accordingly, in a preferred embodiment, segments from a plurality
20 of different polypeptides are linked together to form a synthetic polypeptide according to the invention. It is preferable in this respect to utilise as many parent polypeptides as possible from, or in relation to, a particular source in the construction of the synthetic polypeptide. The source of parent polypeptides includes, but is not limited to, a pathogenic organism and a cancer. Suitably, at least about 30%, preferably at least 40%, more
25 preferably at least 50%, even more preferably at least 60%, even more preferably at least 70%, even more preferably at least 80% and still even more preferably at least 90% of the parent polypeptides expressed by the source is used in the construction of the synthetic polypeptide. Preferably, parent polypeptides from a virus include, but are not restricted to, latent polypeptides, regulatory polypeptides or polypeptides expressed early during their
30 replication cycle. Suitably, parent polypeptides from a parasite or bacterium include, but are not restricted to, secretory polypeptides and polypeptides expressed on the surface of

the parasite or bacteria. It is preferred that parent polypeptides from a cancer or tumour are cancer specific polypeptides.

Suitably, hypervariable sequences within the parent polypeptide are excluded from the construction of the synthetic polypeptide.

5 The synthetic polypeptides of the inventions may be prepared by any suitable procedure known to those of skill in the art. For example, the polypeptide may be synthesised using solution synthesis or solid phase synthesis as described, for example, in Chapter 9 of Atherton and Shephard (1989, *Solid Phase Peptide Synthesis: A Practical Approach*. IRL Press, Oxford) and in Roberge *et al* (1995, *Science* 269: 202). Syntheses
10 may employ, for example, either *t*-butyloxycarbonyl (*t*-Boc) or 9-fluorenylmethyloxycarbonyl (Fmoc) chemistries (see Chapter 9.1, of Coligan *et al.*, *CURRENT PROTOCOLS IN PROTEIN SCIENCE*, John Wiley & Sons, Inc. 1995-1997; Stewart and Young, 1984, *Solid Phase Peptide Synthesis*, 2nd ed. Pierce Chemical Co., Rockford, Ill; and Atherton and Shephard; *supra*).

15 Alternatively, the polypeptides may be prepared by a procedure including the steps of:

(a) preparing a synthetic construct including a synthetic polynucleotide encoding a synthetic polypeptide wherein said synthetic polynucleotide is operably linked to a regulatory polynucleotide, wherein said synthetic polypeptide comprises a plurality of
20 different segments of a parent polypeptide, wherein said segments are linked together in a different relationship relative to their linkage in the parent polypeptide;

(b) introducing the synthetic construct into a suitable host cell;

(c) culturing the host cell to express the synthetic polypeptide from said synthetic construct; and

25 (d) isolating the synthetic polypeptide.

The synthetic construct is preferably in the form of an expression vector. For example, the expression vector can be a self-replicating extra-chromosomal vector such as a plasmid, or a vector that integrates into a host genome. Typically, the regulatory polynucleotide may include, but is not limited to, promoter sequences, leader or signal

sequences, ribosomal binding sites, transcriptional start and stop sequences, translational start and termination sequences, and enhancer or activator sequences. Constitutive or inducible promoters as known in the art are contemplated by the invention. The promoters may be either naturally occurring promoters, or hybrid promoters that combine elements of
5 more than one promoter. The regulatory polynucleotide will generally be appropriate for the host cell used for expression. Numerous types of appropriate expression vectors and suitable regulatory polynucleotides are known in the art for a variety of host cells.

In a preferred embodiment, the expression vector contains a selectable marker gene to allow the selection of transformed host cells. Selection genes are well known in the
10 art and will vary with the host cell used.

The expression vector may also include a fusion partner (typically provided by the expression vector) so that the synthetic polypeptide of the invention is expressed as a fusion polypeptide with said fusion partner. The main advantage of fusion partners is that they assist identification and/or purification of said fusion polypeptide. In order to express
15 said fusion polypeptide, it is necessary to ligate a polynucleotide according to the invention into the expression vector so that the translational reading frames of the fusion partner and the polynucleotide coincide.

Well known examples of fusion partners include, but are not limited to, glutathione-S-transferase (GST), Fc portion of human IgG, maltose binding protein (MBP)
20 and hexahistidine (HIS₆), which are particularly useful for isolation of the fusion polypeptide by affinity chromatography. For the purposes of fusion polypeptide purification by affinity chromatography, relevant matrices for affinity chromatography are glutathione-, amylose-, and nickel- or cobalt-conjugated resins respectively. Many such matrices are available in "kit" form, such as the QIAexpress™ system (Qiagen) useful with
25 (HIS₆) fusion partners and the Pharmacia GST purification system. In a preferred embodiment, the recombinant polynucleotide is expressed in the commercial vector pFLAG™.

Another fusion partner well known in the art is green fluorescent protein (GFP). This fusion partner serves as a fluorescent "tag" which allows the fusion polypeptide of the
30 invention to be identified by fluorescence microscopy or by flow cytometry. The GFP tag is useful when assessing subcellular localisation of a fusion polypeptide of the invention,

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or for isolating cells which express a fusion polypeptide of the invention. Flow cytometric methods such as fluorescence activated cell sorting (FACS) are particularly useful in this latter application. Preferably, the fusion partners also have protease cleavage sites, such as for Factor X_a, Thrombin and inteins (protein introns), which allow the relevant protease to partially digest the fusion polypeptide of the invention and thereby liberate the recombinant polypeptide of the invention therefrom. The liberated polypeptide can then be isolated from the fusion partner by subsequent chromatographic separation. Fusion partners according to the invention also include within their scope "epitope tags", which are usually short peptide sequences for which a specific antibody is available. Well known examples of epitope tags for which specific monoclonal antibodies are readily available include c-Myc, influenza virus, haemagglutinin and FLAG tags. Alternatively, a fusion partner may be provided to promote other forms of immunity. For example, the fusion partner may be an antigen-binding molecule that is immuno-interactive with a conformational epitope on a target antigen or to a post-translational modification of a target antigen (e.g., an antigen-binding molecule that is immuno-interactive with a glycosylated target antigen).

The step of introducing the synthetic construct into the host cell may be effected by any suitable method including transfection, and transformation, the choice of which will be dependent on the host cell employed. Such methods are well known to those of skill in the art.

Synthetic polypeptides of the invention may be produced by culturing a host cell transformed with the synthetic construct. The conditions appropriate for protein expression will vary with the choice of expression vector and the host cell. This is easily ascertained by one skilled in the art through routine experimentation.

Suitable host cells for expression may be prokaryotic or eukaryotic. One preferred host cell for expression of a polypeptide according to the invention is a bacterium. The bacterium used may be *Escherichia coli*. Alternatively, the host cell may be an insect cell such as, for example, *SF9* cells that may be utilised with a baculovirus expression system.

The synthetic polypeptide may be conveniently prepared by a person skilled in the art using standard protocols as for example described in Sambrook, *et al.*, MOLECULAR CLONING. A LABORATORY MANUAL (Cold Spring Harbor Press, 1989), in particular

Sections 16 and 17; Ausubel *et al.*, CURRENT PROTOCOLS IN MOLECULAR BIOLOGY (John Wiley & Sons, Inc. 1994-1998), in particular Chapters 10 and 16; and Coligan *et al.*, CURRENT PROTOCOLS IN PROTEIN SCIENCE (John Wiley & Sons, Inc. 1995-1997), in particular Chapters 1, 5 and 6.

- 5 The amino acids of the synthetic polypeptide can be any non-naturally occurring or any naturally occurring amino acid. Examples of unnatural amino acids and derivatives during peptide synthesis include but are not limited to, use of 4-amino butyric acid, 6-aminohexanoic acid, 4-amino-3-hydroxy-5-phenylpentanoic acid, 4-amino-3-hydroxy-6-methylheptanoic acid, t-butylglycine, norleucine, norvaline, phenylglycine, ornithine,
- 10 sarcosine, 2-thienyl alanine and/or D-isomers of amino acids. A list of unnatural amino acids contemplated by the present invention is shown in TABLE C.

TABLE C

Non-natural amino acid	Non-natural amino acid
α -aminobutyric acid	L-N-methylalanine
α -amino- α -methylbutyrate	L-N-methylarginine
aminocyclopropane-carboxylate	L-N-methylasparagine
aminoisobutyric acid	L-N-methylaspartic acid
aminonorbornyl-carboxylate	L-N-methylcysteine
cyclohexylalanine	L-N-methylglutamine
cyclopentylalanine	L-N-methylglutamic acid
L-N-methylisoleucine	L-N-methylhistidine
D-alanine	L-N-methylleucine
D-arginine	L-N-methyllysine
D-aspartic acid	L-N-methylmethionine
D-cysteine	L-N-methylnorleucine
D-glutamate	L-N-methylnorvaline
D-glutamic acid	L-N-methylornithine

<i>Non-enumerated amino acid</i>	<i>Non-enumerated amino acid</i>
D-histidine	L-N-methylphenylalanine
D-isoleucine	L-N-methylproline
D-leucine	L-N-methylserine
D-lysine	L-N-methylthreonine
D-methionine	L-N-methyltryptophan
D-ornithine	L-N-methyltyrosine
D-phenylalanine	L-N-methylvaline
D-proline	L-N-methylethylglycine
D-serine	L-N-methyl-t-butylglycine
D-threonine	L-norleucine
D-tryptophan	L-norvaline
D-tyrosine	α -methyl-aminoisobutyrate
D-valine	α -methyl- γ -aminobutyrate
D- α -methylalanine	α -methylcyclohexylalanine
D- α -methylarginine	α -methylcyclopentylalanine
D- α -methylassparagine	α -methyl- α -naphthylalanine
D- α -methylasspartate	α -methylpenicillamine
D- α -methylcysteine	N-(4-aminobutyl)glycine
D- α -methylglutamine	N-(2-aminoethyl)glycine
D- α -methylhistidine	N-(3-aminopropyl)glycine
D- α -methylisoleucine	N-amino- α -methylbutyrate
D- α -methylleucine	α -naphthylalanine
D- α -methyllysine	N-benzylglycine
D- α -methylmethionine	N-(2-carbamylethyl)glycine
D- α -methylornithine	N-(carbamylmethyl)glycine

<i>Non-natural amino acid</i>	<i>Non-natural amino acid</i>
D- α -methylphenylalanine	N-(2-carboxyethyl)glycine
D- α -methylproline	N-(carboxymethyl)glycine
D- α -methylserine	N-cyclobutylglycine
D- α -methylthreonine	N-cycloheptylglycine
D- α -methyltryptophan	N-cyclohexylglycine
D- α -methyltyrosine	N-cyclodecylglycine
L- α -methylleucine	L- α -methyllysine
L- α -methylmethionine	L- α -methylnorleucine
L- α -methylnorvaline	L- α -methylornithine
L- α -methylphenylalanine	L- α -methylproline
L- α -methylserine	L- α -methylthreonine
L- α -methyltryptophan	L- α -methyltyrosine
L- α -methylvaline	L-N-methylhomophenylalanine
N-(N-(2,2-diphenylethyl carbamylmethyl)glycine	N-(N-(3,3-diphenylpropyl carbamylmethyl)glycine
1-carboxy-1-(2,2-diphenyl-ethyl amino)cyclopropane	

The invention also contemplates modifying the synthetic polypeptides of the invention using ordinary molecular biological techniques so as to alter their resistance to proteolytic degradation or to optimise solubility properties or to render them more suitable as an immunogenic agent.

3. Preparation of synthetic polynucleotides of the invention

The invention contemplates synthetic polynucleotides encoding the synthetic polypeptides as for example described in Section 2 *supra*. Polynucleotides encoding segments of a parent polypeptide can be produced by any suitable technique. For example, such polynucleotides can be synthesised *de novo* using readily available machinery.

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Sequential synthesis of DNA is described, for example, in U.S. Patent No 4,293,652. Instead of *de novo* synthesis, recombinant techniques may be employed including use of restriction endonucleases to cleave a polynucleotide encoding at least a segment of the parent polypeptide and use of ligases to ligate together in frame a plurality of cleaved polynucleotides encoding different segments of the parent polypeptide. Suitable recombinant techniques are described for example in the relevant sections of Ausubel, *et al.* (*supra*) and of Sambrook, *et al.*, (*supra*) which are incorporated herein by reference. Preferably, the synthetic polynucleotide is constructed using splicing by overlapping extension (SOEing) as for example described by Horton *et al.* (1990, *Biotechniques* 8(5): 528-535; 1995, *Mol Biotechnol.* 3(2): 93-99; and 1997, *Methods Mol Biol.* 67: 141-149). However, it should be noted that the present invention is not dependent on, and not directed to, any one particular technique for constructing the synthetic construct.

Various modifications to the synthetic polynucleotides may be introduced as a means of increasing intracellular stability and half-life. Possible modifications include but are not limited to the addition of flanking sequences of ribo- or deoxy- nucleotides to the 5' and/or 3' ends of the molecule or the use of phosphorothioate or 2' O-methyl rather than phosphodiesterase linkages within the oligodeoxyribonucleotide backbone.

The invention therefore contemplates a method of producing a synthetic polynucleotide as broadly described above, comprising linking together in the same reading frame at least two nucleic acid sequences encoding different segments of a parent polypeptide to form a synthetic polynucleotide, which encodes a synthetic polypeptide according to the invention. Suitably, nucleic acid sequences encoding at least 10 segments, preferably at least 20 segments, more preferably at least 40 segments and more preferably at least 100 segments of a parent polypeptide are employed to produce the synthetic polynucleotide.

Preferably, the method further comprises selecting segments of the parent polypeptide, reverse translating the selected segments and preparing nucleic acid sequences encoding the selected segments. It is preferred that the method further comprises randomly linking the nucleic acid sequences together to form the synthetic polynucleotide. The nucleic acid sequences may be oligonucleotides or polynucleotides.

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Suitably, segments are selected on the basis of size. Additionally, or in the alternative, segments are selected such that they have partial sequence identity or homology (*i.e.*, sequence overlap) with one or more other segments. A number of factors can influence segment size and sequence overlap as mentioned above. In the case of
5 sequence overlap, large amounts of duplicated nucleic acid sequences can sometimes result in sections of nucleic acid being lost during nucleic acid amplification (*e.g.*, polymerase chain reaction, PCR) of such sequences, recombinant plasmid propagation in a bacterial host or during amplification of recombinant viruses containing such sequences. Accordingly, in a preferred embodiment, nucleic acid sequences encoding segments having
10 sequence identity or homology with one or more other encoded segments are not linked together in an arrangement in which the identical or homologous sequences are contiguous. Also, it is preferable that different codons are used to encode a specific amino acid in a duplicated region. In this context, an amino acid of a parent polypeptide sequence is preferably reverse translated to provide a codon which, in the context of adjacent or local
15 sequence elements, has a lower propensity of forming an undesirable sequence (*e.g.*, a duplicated sequence or a palindromic sequence) that is refractory to the execution of a task (*e.g.*, cloning or sequencing). Alternatively, segments may be selected such that they contain a carboxyl terminal leucine residue or such that reverse translated sequences encoding the segments contain restriction enzyme sites for convenient splicing of the
20 reverse translated sequences.

The method optionally further comprises linking a spacer oligonucleotide encoding at least one spacer residue between segment-encoding nucleic acids. Such spacer residue(s) may be advantageous in ensuring that epitopes within the segments are processed and presented efficiently. Preferably, the spacer oligonucleotide encodes 2 to 3
25 spacer residues. The spacer residue is suitably a neutral amino acid, which is preferably alanine.

Optionally, the method further comprises linking in the same reading frame as other segment-containing nucleic acid sequences at least one variant nucleic acid sequence which encodes a variant segment having a homologous but not identical amino acid
30 sequence relative to other encoded segments. Suitably, the variant segment comprises conserved and/or non-conserved amino acid differences relative to one or more other encoded segments. Such differences may correspond to polymorphisms as discussed

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above. In a preferred embodiment, degenerate bases are designed or built in to the at least one variant nucleic acid sequence to give rise to all desired homologous sequences.

When a large number of polymorphisms is intended to be covered, it is preferred that multiple synthetic polynucleotides are constructed rather than a single synthetic polynucleotide, which encodes all variant segments. For example, if there is less than 85% homology between polymorphic polypeptides, then it is preferred that more than one synthetic polynucleotide is constructed.

Preferably, the method further comprises optimising the codon composition of the synthetic polynucleotide such that it is translated efficiently by a host cell. In this regard, it is well known that the translational efficiency of different codons varies between organisms and that such differences in codon usage can be utilised to enhance the level of protein expression in a particular organism. In this regard, reference may be made to Seed *et al.* (International Application Publication No WO 96/09378) who disclose the replacement of existing codons in a parent polynucleotide with synonymous codons to enhance expression of viral polypeptides in mammalian host cells. Preferably, the first or second most frequently used codons are employed for codon optimisation.

Preferably, gene splicing by overlap extension or "gene SOEing" (*supra*) is employed for the construction of the synthetic polynucleotide which is a PCR-based method of recombining DNA sequences without reliance on restriction sites and of directly generating mutated DNA fragments *in vitro*. By modifying the sequences incorporated into the 5'-ends of the primers, any pair of PCR products can be made to share a common sequence at one end. Under PCR conditions, the common sequence allows strands from two different fragments to hybridise to one another, forming an overlap. Extension of this overlap by DNA polymerase yields a recombinant molecule. However, a problem with long synthetic constructs is that mutations generally incorporate into amplified products during synthesis. In this instance, it is preferred that resolvase treatment is employed at various steps of the synthesis. Resolvases are bacteriophage-encoded endonucleases which recognise disruptions or mispairing of double stranded DNA and are primarily used by bacteriophages to resolve Holliday junctions (Mizuuchi, 1982; Youil *et al.*, 1995). For example, T7 endonuclease I can be employed in synthetic DNA constructions to recognise mutations and cleave corrupted dsDNA. The mutated DNA strands are then hybridised to

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non-mutant or correct DNA sequences, which results in a mispairing of DNA bases. The mispaired bases are recognised by the resolvase, which then cleaves the DNA nearby leaving only correctly hybridised sequences intact. Preferably a thermostable resolvase enzyme is employed during splicing or amplification so that errors are not incorporated in downstream synthesis products.

Synthetic polynucleotides according to the invention can be operably linked to a regulatory polynucleotide in the form a synthetic construct as for example described in Section 2 *supra*. Synthetic constructs of the invention have utility *inter alia* as nucleic acid vaccines. The choice of regulatory polynucleotide and synthetic construct will depend on the intended host.

Exemplary expression vectors for expression of a synthetic polypeptide according to the invention include, but are not restricted to, modified Ankara Vaccinia virus as for example described by Allen *et al.* (2000, *J. Immunol.* 164(9): 4968-4978), fowlpox virus as for example described by Boyle and Coupar (1988, *Virus Res.* 10: 343-356) and the herpes simplex amplicons described for example by Fong *et al.* in U.S. Patent No. 6,051,428. Alternatively, Adenovirus and Epstein-Barr virus vectors, which are preferably capable of accepting large amounts of DNA or RNA sequence information, can be used.

Preferred promoter sequences that can be utilised for expression of synthetic polypeptides include the P7.5 or PE/L promoters as for example disclosed by Kumar and Boyle. (1990, *Virology* 179: 151-158), CMV and RSV promoters.

The synthetic construct optionally further includes a nucleic acid sequence encoding an immunostimulatory molecule. The immunostimulatory molecule may be fusion partner of the synthetic polypeptide. Alternatively, the immunostimulatory molecule may be translated separately from the synthetic polypeptide. Preferably, the immunostimulatory molecule comprises a general immunostimulatory peptide sequence. For example, the immunostimulatory peptide sequence may comprise a domain of an invasin protein (Inv) from the bacteria *Yersinia* spp as for example disclosed by Brett *et al.* (1993, *Eur. J. Immunol.* 23: 1608-1614). This immune stimulatory property results from the capability of this invasin domain to interact with the $\beta 1$ integrin molecules present on T cells, particularly activated immune or memory T cells. A preferred embodiment of the invasin domain (Inv) for linkage to a synthetic polypeptide has been previously described

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in U.S. Pat. No. 5,759,551. The said Inv domain has the sequence: Thr-Ala-Lys-Ser-Lys-Lys-Phe-Pro-Ser-Tyr-Thr-Ala-Thr-Tyr-Gln-Phe [SEQ ID NO; 1467] or is an immune stimulatory homologue thereof from the corresponding region in another *Yersinia* species invasin protein. Such homologues thus may contain substitutions, deletions or insertions of
5 amino acid residues to accommodate strain to strain variation, provided that the homologues retain immune stimulatory properties. The general immunostimulatory sequence may optionally be linked to the synthetic polypeptide by a spacer sequence.

In an alternate embodiment, the immunostimulatory molecule may comprise an immunostimulatory membrane or soluble molecule, which is suitably a T cell co-
10 stimulatory molecule. Preferably, the T cell co-stimulatory molecule is a B7 molecule or a biologically active fragment thereof, or a variant or derivative of these. The B7 molecule includes, but is not restricted to, B7-1 and B7-2. Preferably, the B7 molecule is B7-1. Alternatively, the T cell co-stimulatory molecule may be an ICAM molecule such as ICAM-1 and ICAM-2.

15 In another embodiment, the immunostimulatory molecule can be a cytokine, which includes, but is not restricted to, an interleukin, a lymphokine, tumour necrosis factor and an interferon. Alternatively, the immunostimulatory molecule may comprise an immunomodulatory oligonucleotide as for example disclosed by Krieg in U.S. Patent No. 6,008,200.

20 Suitably, the size of the synthetic polynucleotide does not exceed the ability of host cells to transcribe, translate or proteolytically process and present epitopes to the immune system. Practitioners in the art will also recognise that the size of the synthetic polynucleotide can impact on the capacity of an expression vector to express the synthetic polynucleotide in a host cell. In this connection, it is known that the efficacy of DNA
25 vaccination reduces with expression vectors greater than 20-kb. In such situations it is preferred that a larger number of smaller synthetic constructs is utilised rather than a single large synthetic construct.

4. Immunopotentiating compositions

The invention also contemplates a composition, comprising an
30 immunopotentiating agent selected from the group consisting of a synthetic polypeptide as

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described in Section 2, and a synthetic polynucleotide or a synthetic construct as described in Section 3, together with a pharmaceutically acceptable carrier. One or more immunopotentiating agents can be used as actives in the preparation of immunopotentiating compositions. Such preparation uses routine methods known to persons skilled in the art. Typically, such compositions are prepared as injectables, either as liquid solutions or suspensions; solid forms suitable for solution in, or suspension in, liquid prior to injection may also be prepared. The preparation may also be emulsified. The active immunogenic ingredients are often mixed with excipients that are pharmaceutically acceptable and compatible with the active ingredient. Suitable excipients are, for example, water, saline, dextrose, glycerol, ethanol, or the like and combinations thereof. In addition, if desired, the vaccine may contain minor amounts of auxiliary substances such as wetting or emulsifying agents, pH buffering agents, and/or adjuvants that enhance the effectiveness of the vaccine. Examples of adjuvants which may be effective include but are not limited to: aluminium hydroxide, N-acetyl-muramyl-L-threonyl-D-isoglutamine (thur-MDP), N-acetyl-nor-muramyl-L-alanyl-D-isoglutamine (CGP 11637, referred to as nor-MDP), N-acetylmuramyl-L-alanyl-D-isoglutaminyl-L-alanine-2-(1'-2'-dipalmitoyl-sn-glycero-3-hydroxyphosphoryloxy)-ethylamine (CGP 1983A, referred to as MTP-PE), and RIBI, which contains three components extracted from bacteria, monophosphoryl lipid A, trehalose dimycolate and cell wall skeleton (MPL+TDM+CWS) in a 2% squalene/Tween 80 emulsion. For example, the effectiveness of an adjuvant may be determined by measuring the amount of antibodies resulting from the administration of the composition, wherein those antibodies are directed against one or more antigens presented by the treated cells of the composition.

The immunopotentiating agents may be formulated into a composition as neutral or salt forms. Pharmaceutically acceptable salts include the acid addition salts (formed with free amino groups of the peptide) and which are formed with inorganic acids such as, for example, hydrochloric or phosphoric acids, or such organic acids such as acetic, oxalic, tartaric, maleic, and the like. Salts formed with the free carboxyl groups may also be derived from inorganic basis such as, for example, sodium, potassium, ammonium, calcium, or ferric hydroxides, and such organic basis as isopropylamine, trimethylamine, 2-ethylamino ethanol, histidine, procaine, and the like.

If desired, devices or compositions containing the immunopotentiating agents suitable for sustained or intermittent release could be, in effect, implanted in the body or topically applied thereto for the relatively slow release of such materials into the body.

The compositions are conventionally administered parenterally, by injection, for example, either subcutaneously or intramuscularly. Additional formulations which are suitable for other modes of administration include suppositories and, in some cases, oral formulations. For suppositories, traditional binders and carriers may include, for example, polyalkylene glycols or triglycerides; such suppositories may be formed from mixtures containing the active ingredient in the range of 0.5% to 10%, preferably 1%-2%. Oral formulations include such normally employed excipients as, for example, pharmaceutical grades of mannitol, lactose, starch, magnesium carbonate, and the like. These compositions take the form of solutions, suspensions, tablets, pills, capsules, sustained release formulations or powders and contain 10%-95% of active ingredient, preferably 25%-70%.

Administration of the gene therapy construct to said mammal, preferably a human, may include delivery via direct oral intake, systemic injection, or delivery to selected tissue(s) or cells, or indirectly via delivery to cells isolated from the mammal or a compatible donor. An example of the latter approach would be stem cell therapy, wherein isolated stem cells having potential for growth and differentiation are transfected with the vector comprising the *Sox18* nucleic acid. The stem cells are cultured for a period and then transferred to the mammal being treated.

With regard to nucleic acid based compositions, all modes of delivery of such compositions are contemplated by the present invention. Delivery of these compositions to cells or tissues of an animal may be facilitated by microprojectile bombardment, liposome mediated transfection (e.g., lipofectin or lipofectamine), electroporation, calcium phosphate or DEAE-dextran-mediated transfection, for example. In an alternate embodiment, a synthetic construct may be used as a therapeutic or prophylactic composition in the form of a "naked DNA" composition as is known in the art. A discussion of suitable delivery methods may be found in Chapter 9 of CURRENT PROTOCOLS IN MOLECULAR BIOLOGY (Eds. Ausubel *et al.*; John Wiley & Sons Inc., 1997 Edition) or on the Internet site DNA vaccine.com. The compositions may be administered by intradermal (e.g., using panjet™ delivery) or intramuscular routes.

The step of introducing the synthetic polynucleotide into a target cell will differ depending on the intended use and species, and can involve one or more of non-viral and viral vectors, cationic liposomes, retroviruses, and adenoviruses such as, for example, described in Mulligan, R.C., (1993 *Science* 260 926-932) which is hereby incorporated by

5 reference. Such methods can include, for example:

- A. Local application of the synthetic polynucleotide by injection (Wolff *et al.*, 1990, *Science* 247 1465-1468, which is hereby incorporated by reference), surgical implantation, instillation or any other means. This method can also be used in combination with local application by injection, surgical implantation, instillation or
10 any other means, of cells responsive to the protein encoded by the synthetic polynucleotide so as to increase the effectiveness of that treatment. This method can also be used in combination with local application by injection, surgical implantation, instillation or any other means, of another factor or factors required for the activity of said protein.
- 15 B. General systemic delivery by injection of DNA, (Calabretta *et al.*, 1993, *Cancer Treat. Rev.* 19 169-179, which is incorporated herein by reference), or RNA, alone or in combination with liposomes (Zhu *et al.*, 1993, *Science* 261 209-212, which is incorporated herein by reference), viral capsids or nanoparticles (Bertling *et al.*, 1991, *Biotech. Appl. Biochem.* 13 390-405, which is incorporated herein by reference) or any
20 other mediator of delivery. Improved targeting might be achieved by linking the synthetic polynucleotide to a targeting molecule (the so-called "magic bullet" approach employing, for example, an antibody), or by local application by injection, surgical implantation or any other means, of another factor or factors required for the activity of the protein encoding said synthetic polynucleotide, or of cells responsive to said
25 protein.
- C. Injection or implantation or delivery by any means, of cells that have been modified *ex vivo* by transfection (for example, in the presence of calcium phosphate: Chen *et al.*, 1987, *Mole. Cell Biochem.* 7 2745-2752, or of cationic lipids and polyamines: Rose *et al.*, 1991, *BioTech.* 10 520-525, which articles are incorporated herein by reference),
30 infection, injection, electroporation (Shigekawa *et al.*, 1988, *BioTech.* 6 742-751, which is incorporated herein by reference) or any other way so as to increase the

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expression of said synthetic polynucleotide in those cells. The modification can be mediated by plasmid, bacteriophage, cosmid, viral (such as adenoviral or retroviral; Mulligan, 1993, *Science* 260 926-932; Miller, 1992, *Nature* 357 455-460; Salmons *et al.*, 1993, *Hum. Gen. Ther.* 4 129-141, which articles are incorporated herein by reference) or other vectors, or other agents of modification such as liposomes (Zhu *et al.*, 1993, *Science* 261 209-212, which is incorporated herein by reference), viral capsids or nanoparticles (Bertling *et al.*, 1991, *Biotech. Appl. Biochem.* 13 390-405, which is incorporated herein by reference), or any other mediator of modification. The use of cells as a delivery vehicle for genes or gene products has been described by Barr *et al.*, 1991, *Science* 254 1507-1512 and by Dhawan *et al.*, 1991, *Science* 254 1509-1512, which articles are incorporated herein by reference. Treated cells can be delivered in combination with any nutrient, growth factor, matrix or other agent that will promote their survival in the treated subject.

Also encapsulated by the present invention is a method for treatment and/or prophylaxis of a disease or condition, comprising administering to a patient in need of such treatment a therapeutically effective amount of a composition as broadly described above. The disease or condition may be caused by a pathogenic organism or a cancer as for example described above.

In a preferred embodiment, the immunopotentiating composition of the invention is suitable for treatment of, or prophylaxis against, a cancer. Cancers which could be suitably treated in accordance with the practices of this invention include cancers of the lung, breast, ovary, cervix, colon, head and neck, pancreas, prostate, stomach, bladder, kidney, bone liver, oesophagus, brain, testicle, uterus, melanoma and the various leukemias and lymphomas.

In an alternate embodiment, the immunopotentiating composition is suitable for treatment of, or prophylaxis against, a viral, bacterial or parasitic infection. Viral infections contemplated by the present invention include, but are not restricted to, infections caused by HIV, Hepatitis, Influenza, Japanese encephalitis virus, Epstein-Barr virus and respiratory syncytial virus. Bacterial infections include, but are not restricted to, those caused by *Neisseria* species, *Meningococcal* species, *Haemophilus* species *Salmonella* species, *Streptococcal* species, *Legionella* species and *Mycobacterium* species. Parasitic

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infections encompassed by the invention include, but are not restricted to, those caused by *Plasmodium* species, *Schistosoma* species, *Leishmania* species, *Trypanosoma* species, *Toxoplasma* species and *Giardia* species.

The above compositions or vaccines may be administered in a manner compatible
5 with the dosage formulation, and in such amount as is therapeutically effective to alleviate patients from the disease or condition or as is prophylactically effective to prevent incidence of the disease or condition in the patient. The dose administered to a patient, in the context of the present invention, should be sufficient to effect a beneficial response in a patient over time such as a reduction or cessation of blood loss. The quantity of the
10 composition or vaccine to be administered may depend on the subject to be treated inclusive of the age, sex, weight and general health condition thereof. In this regard, precise amounts of the composition or vaccine for administration will depend on the judgement of the practitioner. In determining the effective amount of the composition or vaccine to be administered in the treatment of a disease or condition, the physician may
15 evaluate the progression of the disease or condition over time. In any event, those of skill in the art may readily determine suitable dosages of the composition or vaccine of the invention.

In a preferred embodiment, DNA-based immunopotentiating agent (e.g., 100 µg) is delivered intradermally into a patient at day 1 and at week 8 to prime the patient. A
20 recombinant poxvirus (e.g., at 10^7 pfu/mL) from which substantially the same immunopotentiating agent can be expressed is then delivered intradermally as a booster at weeks 16 and 24, respectively.

The effectiveness of the immunisation may be assessed using any suitable technique. For example, CTL lysis assays may be employed using stimulated splenocytes
25 or peripheral blood mononuclear cells (PBMC) on peptide coated or recombinant virus infected cells using ^{51}Cr labelled target cells. Such assays can be performed using for example primate, mouse or human cells (Allen *et al.*, 2000, *J. Immunol.* 164(9): 4968-4978 also Woodberry *et al.*, *infra*). Alternatively, the efficacy of the immunisation may be monitored using one or more techniques including, but not limited to, HLA class I
30 Tetramer staining - of both fresh and stimulated PBMCs (see for example Allen *et al.*, *supra*), proliferation assays (Allen *et al.*, *supra*), Elispot™ Assays and intracellular INF-

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gamma staining (Allen *et al.*, *supra*), ELISA Assays - for linear B cell responses; and Western blots of cell sample expressing the synthetic polynucleotides.

5. Computer related embodiments

The design or construction of a synthetic polypeptide sequence or a synthetic polynucleotide sequence according to the invention is suitably facilitated with the assistance of a computer programmed with software, which *inter alia* fragments a parent sequence into fragments, and which links those fragments together in a different relationship relative to their linkage in the parent sequence. The ready use of a parent sequence for the construction of a desired synthetic molecule according to the invention requires that it be stored in a computer-readable format. Thus, in accordance with the present invention, sequence data relating to a parent molecule (*e.g.*, a parent polypeptide) is stored in a machine-readable storage medium, which is capable of processing the data to fragment the sequence of the parent molecule into fragments and to link together the fragments in a different relationship relative to their linkage in the parent molecule.

Therefore, another embodiment of the present invention provides a machine-readable data storage medium, comprising a data storage material encoded with machine readable data which, when used by a machine programmed with instructions for using said data, fragments a parent sequence into fragments, and links those fragments together in a different relationship relative to their linkage in the parent sequence. In a preferred embodiment of this type, a machine-readable data storage medium is provided that is capable of reverse translating the sequence of a respective fragment to provide a nucleic acid sequence encoding the fragment and to link together in the same reading frame each of the nucleic acid sequences to provide a polynucleotide sequence that codes for a polypeptide sequence in which said fragments are linked together in a different relationship relative to their linkage in a parent polypeptide sequence.

In another embodiment, the invention encompasses a computer for designing the sequence of a synthetic polypeptide and/or a synthetic polynucleotide of the invention, wherein the computer comprises wherein said computer comprises: (a) a machine readable data storage medium comprising a data storage material encoded with machine readable data, wherein said machine readable data comprises the sequence of a parent polypeptide; (b) a working memory for storing instructions for processing said machine-readable data;

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(c) a central-processing unit coupled to said working memory and to said machine-readable data storage medium, for processing said machine-readable data into said synthetic polypeptide sequence and/or said synthetic polynucleotide; and (d) an output hardware coupled to said central processing unit, for receiving said synthetic polypeptide sequence
5 and/or said synthetic polynucleotide.

In yet another embodiment, the invention contemplates a computer program product for designing the sequence of a synthetic polynucleotide of the invention, comprising code that receives as input the sequence of a parent polypeptide, code that fragments the sequence of the parent polypeptide into fragments, code that reverse
10 translates the sequence of a respective fragment to provide a nucleic acid sequence encoding the fragment, code that links together in the same reading frame each said nucleic acid sequence to provide a polynucleotide sequence that codes for a polypeptide sequence in which said fragments are linked together in a different relationship relative to their linkage in the parent polypeptide sequence, and a computer readable medium that stores
15 the codes.

A version of these embodiments is presented in Figure 23, which shows a system
10 including a computer 11 comprising a central processing unit ("CPU") 20, a working memory 22 which may be, e.g., RAM (random-access memory) or "core" memory, mass storage memory 24 (such as one or more disk drives or CD-ROM drives), one or more
20 cathode-ray tube ("CRT") display terminals 26, one or more keyboards 28, one or more input lines 30, and one or more output lines 40, all of which are interconnected by a conventional bidirectional system bus 50.

Input hardware 36, coupled to computer 11 by input lines 30, may be implemented in a variety of ways. For example, machine-readable data of this invention
25 may be inputted via the use of a modem or modems 32 connected by a telephone line or dedicated data line 34. Alternatively or additionally, the input hardware 36 may comprise CD. Alternatively, ROM drives or disk drives 24 in conjunction with display terminal 26, keyboard 28 may also be used as an input device.

Output hardware 46, coupled to computer 11 by output lines 40, may similarly be
30 implemented by conventional devices. By way of example, output hardware 46 may include CRT display terminal 26 for displaying a synthetic polynucleotide sequence or a synthetic polypeptide sequence as described herein. Output hardware might also include a

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printer 42, so that hard copy output may be produced, or a disk drive 24, to store system output for later use.

In operation, CPU 20 coordinates the use of the various input and output devices 36,46 coordinates data accesses from mass storage 24 and accesses to and from working
5 memory 22, and determines the sequence of data processing steps. A number of programs may be used to process the machine readable data of this invention. Exemplary programs may use for example the steps outlined in the flow diagram illustrated in Figure 24. Broadly, these steps include (1) inputting at least one parent polypeptide sequence; (2) optionally adding to alanine spacers at the ends of each polypeptide sequence; (3)
10 fragmenting the polypeptide sequences into fragments (e.g., 30 amino acids long), which are preferably overlapping (e.g., by 15 amino acids); (4) reverse translating the fragment to provide a nucleic acid sequence for each fragment and preferably using for the reverse translation first and second most translationally efficient codons for a cell type, wherein the codons are preferably alternated out of frame with each other in the overlaps of
15 consecutive fragments; (5) randomly rearranging the fragments; (6) checking whether rearranged fragments recreate at least a portion of a parent polypeptide sequence; (7) repeating randomly rearranging the fragments when rearranged fragments recreate said at least a portion; or otherwise (8) linking the rearranged fragments together to produce a synthetic polypeptide sequence and/or a synthetic polynucleotide sequence; and (9)
20 outputting said synthetic polypeptide sequence and/or a synthetic polynucleotide sequence. An example of an algorithm which uses *inter alia* the aforementioned steps is shown in Figure 25. By way of example, this algorithm has been used for the design of synthetic polynucleotides and synthetic polypeptides according to the present invention for Hepatitis C 1a and for melanoma, as illustrated in Figures 26 and 27.

25 Figure 28 shows a cross section of a magnetic data storage medium 100 which can be encoded with machine readable data, or set of instructions, for designing a synthetic molecule of the invention, which can be carried out by a system such as system 10 of Figure 23. Medium 100 can be a conventional floppy diskette or hard disk, having a suitable substrate 101, which may be conventional, and a suitable coating 102, which may
30 be conventional, on one or both sides, containing magnetic domains (not visible) whose polarity or orientation can be altered magnetically. Medium 100 may also have an opening (not shown) for receiving the spindle of a disk drive or other data storage device 24. The

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magnetic domains of coating 102 of medium 100 are polarised or oriented so as to encode in manner which may be conventional, machine readable data such as that described herein, for execution by a system such as system 10 of Figure 23.

Figure 29 shows a cross section of an optically readable data storage medium 110 which also can be encoded with such a machine-readable data, or set of instructions, for designing a synthetic molecule of the invention, which can be carried out by a system such as system 10 of Figure 23. Medium 110 can be a conventional compact disk read only memory (CD-ROM) or a rewritable medium such as a magneto-optical disk, which is optically readable and magneto-optically writable. Medium 100 preferably has a suitable substrate 111, which may be conventional, and a suitable coating 112, which may be conventional, usually of one side of substrate 111.

In the case of CD-ROM, as is well known, coating 112 is reflective and is impressed with a plurality of pits 113 to encode the machine-readable data. The arrangement of pits is read by reflecting laser light off the surface of coating 112. A protective coating 114, which preferably is substantially transparent, is provided on top of coating 112.

In the case of a magneto-optical disk, as is well known, coating 112 has no pits 113, but has a plurality of magnetic domains whose polarity or orientation can be changed magnetically when heated above a certain temperature, as by a laser (not shown). The orientation of the domains can be read by measuring the polarisation of laser light reflected from coating 112. The arrangement of the domains encodes the data as described above.

In order that the invention may be readily understood and put into practical effect, particular preferred non-limiting embodiments will now be described as follows.

EXAMPLES

EXAMPLE 1

Preparation of an HIV Savine

Experimental Protocol

5 *Plasmids*

The plasmid pDNAVacc is ampicillin resistant and contains an expression cassette comprising a CMV promoter and enhancer, a synthetic intron, a multiple cloning site (MCS) and a SV40poly A signal sequence (Thomson *et al.*, 1998). The plasmid pTK7.5 and contains a selection cassette, a pox virus 7.5 early/late promoter and a MCS
10 flanked on either side by Vaccinia virus TK gene sequences.

Recombinant Vaccinia Viruses

Recombinant Vaccinia viruses expressing the *gag*, *env* (IIB) and *pol* (LAI) genes of HIV-1 were used as previously described and denoted VV-GAG, VV-POL, VV-ENV (Woodberry *et al.*, 1999; Kent *et al.*, 1998).

15 *Marker Rescue Recombination*

Recombinant Vaccinia viruses containing Savine constructs were generated by marker rescue recombination, using protocols described previously (Boyle *et al.*, 1985). Plaque purified viruses were tested for the TK phenotype and for the appropriate genome arrangement by Southern blot and PCR.

20 *Oligonucleotides*

Oligonucleotides 50 nmol scale and desalted were purchased from Life Technologies. Short oligonucleotides were resuspended in 100 µL of water, their concentration determined, then diluted to 20 µM for use in PCR or sequencing reactions. Long oligonucleotides for splicing reactions were denatured for 5 minutes at 94°C in
25 20 µL of formamide loading buffer then 0.5 µL gel purified on a 6% polyacrylamide gel.

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Gel slices containing full-length oligonucleotides were visualised with ethidium bromide, excised, placed in Eppendorf™ tubes, combined with 200 µL of water before being crushed using the plunger of a 1 mL syringe. Before being used in splicing reactions the crushed gel was resuspended in an appropriate volume of buffer and 1-2 µL of the
5 resuspendate used directly in the splicing reactions.

Sequencing

Sequencing was performed using Dye terminator sequencing reactions and analyzed by the Biomedical Resource Facility at the John Curtin School of Medical Research using an ABI automated sequencer.

10 *Restimulation of Lymphocytes from HIV Infected Patients*

Two pools of recombinant Vaccinia viruses containing VV-AC1 + VV-BC1 (Pool 1) or VV-AC2 + VV-BC2 + VV-CC2 (Pool 2) were used to restimulate lymphocytes from the blood samples of HIV-infected patients. Briefly CTL lines were generated from HIV-infected donor PBMC. A fifth of the total PBMC were infected with either Pool 1 or Pool 2
15 Vaccinia viruses then added back to the original cell suspension. The infected cell suspension was then cultured with IL-7 for 1 week.

CTL Assays

Restimulated PBMCs were used as effectors in a standard ⁵¹Cr-release CTL assay. Targets were autologous EBV-transformed lymphoblastoid cell lines (LCLs) infected with
20 the following viruses : Pool 1, Pool 2, VV-GAG, VV-POL or VV-ENV. Assay controls included uninfected targets, targets infected with VV-lacZ (virus control) and K562 cells.

Results

HIV Savine Design

A main goal of the Savine strategy is to include as much protein sequence
25 information from a pathogen or cancer as possible in such a way that potential T cell epitopes remain intact and so that the vaccine or therapy is extremely safe. An HIV Savine is described herein not only to compare this strategy to other strategies but also, to produce

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an HIV vaccine that would provide the maximum possible population coverage as well as catering for the major HIV clades.

A number of design criteria was first determined to exploit the many advantages of using a synthetic approach. One advantage is that it is possible to use consensus protein sequences to design these vaccines. Using consensus sequences for a highly variable virus like HIV should provide better vaccine coverage because individual viral isolate sequences may have lost epitopes which induce CTL against the majority of other viral isolates. Thus, using the consensus sequences of each HIV clade rather than individual isolate sequences should provide better vaccine coverage. Taking this one step further, a consensus sequence that covers all HIV clades should theoretically provide better coverage than using just the consensus sequences for individual clades. Before designing such a sequence however, it was decided that a more appropriate and focussed HIV vaccine might be constructed if the various clades were first ranked according to their relative importance. To establish such a ranking the following issues were considered, current prevalence of each clade, the rate at which each clade is increasing and the capacity of various regions of the world to cope with the HIV pandemic (Figures 1 and 2). These criteria produced the following ranking, Clade E \geq clade A > clade C > clade B > clade D > other clades. Clades E and A were considered to almost equal since they are very similar except in their envelope protein sequences, which differ considerably.

Another advantage of synthesising a designed sequence is that it is possible to incorporate degenerate sequences into their design. In the case of HIV, this means that more than one amino acid can be included at various positions to improve the ability of the vaccine to cater for the various HIV clades and isolates. Coverage is improved because mutations in different HIV clades and also in individual isolate sequences, while mostly destroying specific T cell epitopes, can result in the formation of new potentially useful epitopes nearby (Goulder *et al.*, 1997). Incorporating degenerate amino acid sequences, however, also means that more than one construct must be made and mixed together. The number of constructs required depends on the frequency with which mutations are incorporated into the design. While this approach requires the construction of additional constructs, these constructs can be prepared from the same set of degenerate long oligonucleotides, significantly reducing the cost of providing such considerable interclade coverage.

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A set of degeneracy rules was developed for the incorporation of amino acid mutations into the design which meant that a maximum of eight constructs would be required so that theoretically all combinations were present, as follows: 1) Two amino acids at three positions (or less) within any group of nine amino acids (*i.e.*, present in a CTL epitope); 2) Three amino acids at one position and two at another (or not) within any group of nine amino acids; 3) Four amino acids at one position and two at another (or not) within any group of nine amino acids. The reason why these rules were applied to nine amino acids (the average CTL epitope size) and not to larger stretches of amino acid sequence to cater for class II restricted epitopes, is because class II-restricted epitopes generally have a core sequence of nine amino acids in the middle which bind specifically to class II MHC molecules with the extra flanking sequences stabilising binding, by associating with either side of class II MHC antigens in a largely sequence independent manner (Brown *et al.*, 1993).

Using the HIV clade ranking described above, the amino acid degeneracy rules and in some situations the similarity between amino acids, a degenerate consensus protein sequence was designed for each HIV protein using the consensus protein sequences for each HIV clade compiled by the Los Alamos HIV sequence database (Figures 3-11) (HIV Molecular Immunology Database, 1997). It is important to note that in some situations the order with which each of the above design criteria was applied was altered. Each time this was done the primary goal however was to increase the ability of the vaccine to cater for interclade differences. Two isolate sequences, GenBank accession U51189 and U46016, for clade E and clade C, respectively, were used when a consensus sequence for some HIV proteins from these two clades was unavailable (Gao *et al.*, 1996; Salminen *et al.*, 1996). The design of a consensus sequence for the hypervariable regions of the HIV envelope protein and in some cases between these regions (hypervariable regions 1-2 and 3-5) was difficult and so these regions were excluded from the vaccine design.

Once a degenerate consensus sequence was designed for each HIV protein, an approach was then determined for incorporating all the protein sequences safely into the vaccine. One convenient approach to ensure that a vaccine will be safe is to systematically fragment and randomly rearrange the protein sequences together thus abrogating or otherwise altering their structure and function. The protein sequences still have to be immunologically functional however, meaning that the process used to fragment the

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sequences should not destroy potential epitopes. To decide on the best approach for systematically fragmenting protein sequences, the main criteria used was the size of T epitopes and their processing requirements. Class I-restricted T cell epitopes are 8-10 amino acids long and generally require 2-3 natural flanking amino acids to ensure their efficient processing and presentation if placed next to unnatural flanking residues (Del Val *et al.*, 1991; Thomson *et al.*, 1995). Class II-restricted T cell epitopes range between 12-25 amino acids long and do appear to require natural flanking residues for processing however, it is difficult to rule out a role for natural flanking residues in all cases due to the complexity of their processing pathways (Thomson *et al.*, 1998). Also class II-restricted epitopes despite being larger than CTL epitopes generally have a core sequence of 9-10 amino acids, which binds to MHC molecules in a sequence specific fashion. Thus, based on current knowledge, it was decided that an advantageous approach was to overlap the fragments by at least 15 amino acids to ensure that potential epitopes which might lie across fragment boundaries are not lost and to ensure that CTL epitopes near fragment boundaries, that are placed beside or near inhibitory amino acids in adjacent fragments, are processed efficiently. In deciding the optimal fragment size, the main criteria used were that size had to be small enough to cause the maximum disruption to the structure and function of proteins but large enough to cover the sequence information as efficiently as possible without any further unnecessary duplication. Based on these criteria the fragments would be twice the overlap size, in this case 30 amino acids long.

The designed degenerate protein sequences were then separated into fragments 30 amino acid long and overlapping by fifteen amino acids. Two alanine amino acids were also added to the start and end of the first and last fragment for each protein or envelop protein segment to ensure these fragments were not placed directly adjacent to amino acids capable of blocking epitope processing (Del Val *et al.*, 1991). The next step was to reverse translate each protein sequence back into DNA. Duplicating DNA sequences was avoided when constructing DNA sequences encoding a tandem repeat of identical or homologous amino acid sequences to maximise expression of the Savine. In this regard, the first and second most commonly used mammalian codons (shown in Figure 12) were assigned to amino acids in these repeat regions, wherein a first codon was used to encode an amino acid in one of the repeated sequences and wherein a second but synonymous codon was used for the other repeated sequence (*e.g.*, see the gag HIV protein in Figure 13). To cater

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for the designed amino acid mutations more than one base was assigned to some positions using the IUPAC DNA codes without exceeding more than three base variations (eight possible combinations) in any group of 27 bases (Figure 12). Where a particular combination of amino acids could not be incorporated, because too many degenerate bases would be required, some or all of the amino acid degeneracy was removed according to the protein consensus design rules outlined above. Also the degenerate codons were checked to determine if they could encode a stop codon, if stop codons could not be avoided then the amino acid degeneracy was also simplified again according to the protein consensus design rules outlined above.

10 The designed DNA segments were then scrambled randomly and joined to create twenty-two subcassettes approximately 840 bp in size. Extra DNA sequences incorporating sites for one of the cohesive restriction enzymes *XbaI*, *SpeI*, *AvrII* or *NheI* and 3 additional base pairs (to cater for premature Taq polymerase termination) were then added to each end of each subcassette (Figure 14). Some of these extra DNA sequences also contained, 15 the cohesive restriction sites for *SaII* or *XhoI*, Kozak signal sequences and start or stop codons to enable the subcassettes to be joined and expressed either as three large cassettes or one full length protein (Figures 14 and 15).

In designing the HIV Savine one issue that required investigation was whether such a large DNA molecule would be fully expressed and whether epitopes encoded near 20 the end of the molecule would be efficiently presented to the immune system. The inventors also wished to show that mixing two or more degenerate Savine constructs together could induce T cell responses that recognise mutated sequences. To examine both issues DNA coding for a degenerate murine influenza nucleoprotein CTL epitope, NP365-373, which differs by two amino acids at positions 71 and 72 in influenza strain A/PR/8/34 25 compared to the A/NT/60/68 strain and restricted by H2-Db, was inserted before the last stop codon at the end of the HIV Savine design (Figure 15). An important and unusual characteristic of both of these naturally occurring NP365-373 sequences, which enabled the present inventors to examine the effectiveness of incorporating mutated sequences, is that they generate CTL responses which do not cross react with the alternate sequence 30 (Townsend *et. al.*, 1986). This is an unusual characteristic because epitopes not destroyed by mutation usually induce CTL responses that cross-react.

Up to ten long oligonucleotides up to 100 bases long and two short amplification oligonucleotides were synthesised to enable construction of each subcassette (Life Technologies). In designing each oligonucleotide the 3' end and in most cases also the 5' end had to be either a 'c' or a 'g' to ensure efficient extension during PCR splicing. The overlap region for each long oligonucleotide was designed to be at least 16 bp with approximately 50% G/C content. Also oligonucleotide overlaps were not placed where degenerate DNA bases coded for degenerate amino acids to avoid splicing difficulties later. Where this was too difficult some degenerate bases were removed according to the protein consensus design rules outlined above and indicated in Figure 12. Figure 16 shows an example of the oligonucleotides design for each subcassette.

Construction of the HIV Savine

Five of each group of ten designed oligonucleotides were spliced together using stepwise asymmetric PCR (Sandhu *et al.*, 1992) and Splicing by Overlap Extension (SOEing) (Figure 17a). Each subcassette was then PCR amplified, cloned into pBluescript™ II KS⁻ using *Bam*HI/*Eco*RI and 16 individual clones sequenced. Mutations, deletions and insertions were present in the large majority of the clones for each subcassette, despite acrylamide gel purification of the long oligonucleotides. In order to construct a functional Savine with minimal mutations, two clones for each subcassette with no insertions or deletions and hence a complete open reading frame and with minimal numbers of non-designed mutations, were selected from the sixteen available. The subcassettes were then excised from their plasmids and joined by stepwise PCR-amplified ligation using the polymerase blend Elongase™ (Life Technology), T4 DNA ligase and the cohesive restriction enzymes *Xba*I/*Spe*I/*Avr*II/*Nhe*I, to generate two copies of cassettes A, B and C as outlined in Figure 14 and shown in Figure 17b. Predicted sequences for these cassettes are shown in Figure 30. Each cassette was then reamplified by PCR with Elongase™, cloned into pBluescript™ II KS⁻ and 3 of the resulting plasmid clones sequenced using 12 of the 36 sequencing primers designed to cover the full length construct. Clones with minimal or no further mutations were selected for transfer into plasmids for DNA vaccination or used to make recombinant poxviruses. A summary of the number of designed and non-designed mutations in each Savine construct is presented in Table 1.

TABLE 1

Summary of mutations

Cassette	Number	Number of mutations			
		Designed	Expected	Actual	Non-designed
Cassette A	1896	249	124	107	5 (AC1), 8 (AC2)
Cassette B	1184	260	130	124	11 (BC1), 4 (BC2)
Cassette C	1969	276	138	121	10 (CC1), 14 (CC2)
Full length	5742	785	392	352	26 (FL1), 26 (FL2)

Summary of the mutations present in the two full-length clones constructed as determined by sequencing. Includes the number of mutations designed, expected and actually present in the 2 clones and the number of non-designed mutations in each cassette and full-length clone.

HIV Savine DNA vaccines and Recombinant Vaccinia viruses

To test the immunological effectiveness of the HIV Savine constructs the cassette sequences were transferred into DNA vaccine and poxvirus vectors. These vectors when used either separately in immunological assays described below or together in a 'prime-boost' protocol which has been shown previously to generate strong T cell responses *in vivo* (Kent *et al.*, 1997).

DNA Vaccination plasmids were constructed by excising the cassettes from the selected plasmid clones with *XbaI/XhoI* (cassette A) or *XbaI/SaI* (cassettes B and C) and ligating them into pDNAVacc cut with *XbaI/XhoI* to create pDVAC1, pDVAC2, pDVBC1, pDVBC2, pDVCC1, pDVCC2, respectively (Figure 18a). These plasmids were then further modified by cloning into their *XbaI* site a DNA fragment excised using *XbaI/AvrII* from pTUMERA2 and encoding a synthetic endoplasmic reticulum (ER) signal sequence from the Adenovirus E1A protein (Persson *et al.*, 1980) (Figure 18a). ER signal sequences have been shown previously to enhance the presentation of both CTL and T helper epitopes *in vivo* (Ishioka, G.Y., 1999; Thomson *et al.*, 1998). The plasmids pDVERAC1, pDVERBC1, pDVERCC1 and pDVERAC2, pDVERBC2, pDVERCC2 were then mixed

together to create, plasmid pool 1 and pool 2 respectively. Each plasmid pool collectively encodes one copy of the designed full-length HIV Savine.

Plasmids to generate recombinant Vaccinia viruses which express HIV Savine sequences were constructed by excising the various HIV Savine cassettes from the selected plasmid clones using *Bam*HI/*Xho*I (cassette A) or *Bam*HI/*Sal*I (cassettes B and C) and cloned into the marker rescue plasmid, pTK7.5, cleaved with *Bam*HI/*Sal*I. These pTK7.5-derived plasmids were then used to generate recombinant Vaccinia viruses by marker rescue recombination using established protocols (Boyle *et al.*, 1985) to generate VV-AC1, VV-AC2, VV-BC1, VV-BC2, VV-CC1 and VV-CC2 (Figure 18b).

Two further DNA vaccine plasmids were constructed each encoding a version of the full length HIV Savine (Figure 18c). Briefly, the two versions of cassette B were excised with *Xho*I and cloned into the corresponding selected plasmid clones containing cassette A sequences that were cut with *Xho*I/*Sal*I to generate pBSAB1 and pBSAB2 respectively. The joined A/B cassettes in pBSAB1 and pBSAB2 were excised with *Xba*I/*Xho*I and cloned into pDVCC1 and pDVCC2, respectively, and cleaved with *Xba*I/*Xho*I to generate pDVFL1 and pDVFL2. These were then further modified to contain an ER signal sequence using the same cloning strategy as outlined in figure 18a.

Restimulation of HIV specific lymphocytes from HIV infected patients

The present inventors examined the capacity of the HIV Savine to restimulate HIV-specific polyclonal CTL responses from HIV-infected patients. PBMCs from three different patients were restimulated *in vitro* with two HIV Savine Vaccinia virus pools (Pool 1 included VV-AC1 and VV-BC1; Pool 2 included VV-AC2, VV-BC2 and VV-CC2) then used in CTL lysis assays against LCLs infected either with one of the Savine Vaccinia virus pools or Vaccinia viruses which express gag, env or pol. Figure 19 clearly shows, that in all three assays, both HIV Savine viral pools restimulated HIV-specific CTL responses which could recognise targets expressing whole natural HIV antigens and not targets which were uninfected or infected with the control Vaccinia virus. Furthermore, in all three cases, both pools restimulated responses that recognised all three natural HIV antigens. This result suggests that the combined Savine constructs will provide broader immunological coverage than single antigen based vaccine approaches. The level of lysis in each case of targets infected with Savine viral pools was significantly higher than the

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lysis recorded for any other infected target. This probably reflects the combined CTL responses to gag, pol, and env plus other HIV antigens not analysed here but whose sequences are also incorporated into the Savine constructs.

CTL recognition of each HIV antigen is largely controlled by each patient's HLA background hence the pattern of CTL lysis for whole HIV antigens is different in each patient. Interestingly, this CTL lysis pattern did not change when the second Savine Vaccinia virus pool was used for CTL restimulation. In these assays, therefore, the inventors were unable to demonstrate clear differences between pools 1 and 2, despite pool 1 lacking a Vaccinia virus expressing cassette CC1 and despite the many amino acid differences between the A and B cassettes in each pool (see table 1).

From the foregoing, the present inventors have developed a novel vaccine/therapeutic strategy. In one embodiment, pathogen or cancer protein sequences are systemically fragmented, reverse translated back into DNA, rearranged randomly then joined back together. The designed synthetic DNA sequence is then constructed using long oligonucleotides and can be transferred into a range of delivery vectors. The vaccine vectors used here were DNA vaccine plasmids and recombinant poxvirus vectors which have been previously shown to elicit strong T cell responses when used together in a 'prime-boost' protocol (Kent *et al.*, 1997). An important advantage of scrambled antigen vaccines or 'Savines' is that the amount of starting sequence information for the design can be easily expanded to include the majority of the protein sequences from a pathogen or for cancer, thereby providing the maximum possible vaccine or therapy coverage for a given population.

An embodiment of the systematic fragmentation approach described herein was based on the size and processing requirements for T cell epitopes and was designed to cause maximal disruption to the structure and function of protein sequences. This fragmentation approach ensures that the maximum possible range of T cell epitopes will be present from any incorporated protein sequence without the protein being functional and able to compromise vaccine safety

Another important advantage of Savines is that consensus protein sequences can be used for their design. This feature is only applicable when the design needs to cater for pathogen or cancer antigens whose sequence varies considerably. HIV is a highly

mutagenic virus, hence this feature was utilised extensively to design a vaccine which has the potential to cover not only field isolates of HIV but also the major HIV clades involved in the current HIV pandemic. To construct the HIV Savine, one set of long oligonucleotides was synthesised, which included degenerate bases in such a way that 8 constructs are theoretically required for the vaccine to contain all combinations in any stretch of 9 amino acids. The inventors believe that this approach can be improved for the following reasons: 1) While degenerate bases should be theoretically equally represented, in practice some degenerate bases were biased towards one base or the other, leading to a lower than expected frequency of the designed mutations in the two full length HIV Savines which were constructed (see Table 1). 2) Only sequence combinations actually present in the HIV clade consensus sequences are required to get full clade coverage, hence the number of full length constructs needed could be reduced. To reduce the number of constructs however, separate sets of long oligonucleotides would have to be synthesised, significantly increasing the cost, time and effort required to generate a vaccine capable of such considerable vaccine coverage.

A significant problem during the construction of the HIV Savine synthetic DNA sequence was the incorporation of non-designed mutations. The most serious types of mutations were insertions, deletions or those giving rise to stop codons, all of which change the frame of the synthesised sequences and/or caused premature truncation of the Savine proteins. These types of mutation were removed during construction of the HIV Savines by sequencing multiple clones after subcassette and cassette construction and selecting functional clones. The major source of these non-designed mutations was in the long oligonucleotides used for Savine synthesis, despite their gel purification. This problem could be reduced by making the initial subcassettes smaller thereby reducing the possibility of corrupted oligonucleotides being incorporated into each subcassette clone. The second major cause of non-designed mutations was the large number of PCR cycles required for the PCR and ligation-mediated joining of the subcassettes. Including extra sequencing and clone selection steps during the subcassette joining process should help to reduce the frequency of non-designed mutations in future constructs. Finally, another method that could help reduce the frequency of such mutations at all stages is to use resolvase treatment. Resolvases are bacteriophage-encoded endonucleases which recognise disruptions to double stranded DNA and are primarily used by bacteriophages to resolve

Holliday junctions (Mizuuchi, 1982; Youil *et al.*, 1995). T7 endonuclease I has already been used by the present inventors in synthetic DNA constructions to recognise mutations and cleave corrupted dsDNA to allow gel purification of correct sequences. Cleavage of corrupted sequences occurs because after a simple denaturing and hybridisation step mutated DNA hybridises to correct DNA sequences and results in a mispairing of DNA bases which is able to be recognised by the resolvase. This method resulted in a 50% reduction in the frequency of errors. Further optimisation of this method and the use of a thermostable version of this type of enzyme could further reduce the frequency of errors during long Savine construction.

Two pools of Vaccinia viruses expressing Savine cassettes were both shown to restimulate HIV-specific responses from three different patients infected with B clade HIV viruses. These results provide a clear indication that the HIV Savine should provide broad coverage of the population because each patient had a different HLA pattern yet both pools were able to restimulate HIV-specific CTL responses in all three patients against all three natural HIV proteins tested. Also, both pools were shown to restimulate virtually identical CTL patterns in all three patients. This result was unexpected because some responses should have been lost or gained due to the amino acid differences between the two pools and because Pool 1 is only capable of expressing 2/3 of the full length HIV Savine. There are two suggested reasons why the pattern of CTL lysis was not altered between the two viral pools. Firstly, the sequences in the Savine constructs are nearly all duplicated because the fragment sequences overlap. Hence the loss of a third of the Savine may not have excluded sufficient T cell epitopes for differences to be detected in only three patient samples against only three HIV proteins. Secondly, while mutations often destroy T cell epitopes, if they remain functional, then the CTL they generate frequently can recognise alternate epitope sequences. Taken together this finding indirectly suggests that combining only two Savine constructs may provide robust multiclade coverage. Further experiments are being carried out to directly examine the capacity of the HIV Savine to stimulate CTL generated by different strains of HIV virus. The capacity of the two HIV-1 Savine Vaccinia vector pools to stimulate CD4+ T cell HIV-1 specific responses from infected patients was also tested (Figure 20). Both patients showed significant proliferation of CD4+ T cells although both pools did not show consistent patterns suggesting that the two pools may provide wider vaccine coverage than using either pool independently.

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The present inventors have generated a novel vaccine strategy, which has been used to generate what the inventors believe to be the most effective HIV candidate vaccine to date. The inventors have used this vaccine to immunise naïve mice. Figure 21 shows conclusively that the HIV-1 Savine described above can generate a Gag and Nef CTL response in naïve mice. It should be noted, however, that the Nef CTL epitope appeared to exist only in Pool 1 since it was not restimulated by Pool 2. This is further proof of the utility of combining HIV-1 Savine Pool 1 and Pool 2 components together to provide broader vaccine coverage.

The HIV-1 Savine Vaccinia vectors have also been used to restimulate *in vivo* HIV-1 responses in pre-immune *M. nemestrina* monkeys. These experiments (Figure 22) showed, by INF- γ ELISPOT and CD69 expression on both CD4 and CD8 T cells, that the ability of the HIV-1 SAVINE to restimulate HIV-1 specific responses *in vivo* is equivalent or perhaps better than another HIV-1 candidate vaccine.

This is a generic strategy able to be applied to many other human infections or cancers where T-cell responses are considered to be important for protection or recovery. With this in mind the inventors have begun constructing Savines for melanoma, cervical cancer and Hepatitis C. In the case of melanoma, the majority of the currently identified melanoma antigens have been divided into two groups, one containing antigens associated with melanoma and one containing differentiation antigens from melanocytes, which are often upregulated in melanomas. Two Savine constructs are presently being constructed to cater for these two groups. The reason for making the distinction is that treatment of melanoma might first proceed using the Savine that incorporates fragments of melanoma specific antigens only. If this Savine fails to control some metastases then the less specific Savine containing the melanocyte-specific antigens can then be used. It is important to point out that other cancers also express many of the antigens specific to melanomas *e.g.*, testicular and breast cancers. Hence the melanoma specific Savine may have therapeutic benefits for other cancers.

A small Savine is also being constructed for cervical cancer. This Savine will contain two antigens, E6 and E7, from two strains of human papilloma virus (HPV), HPV-16 and HPV-18, directly linked with causing the majority of cervical cancers worldwide. There is a large number of sequence differences in these two antigens between the two

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strains which would normally require two Savines to be constructed. However since this Savine is small, the antigen fragments from both strains are being scrambled together. While it is normally better for the Savine approach to include all or a majority of the antigens from a virus, in this case only E6 and E7 are expressed during viral latency or in cervical carcinomas. Hence in the interests of simplicity, the rest of the HPV genome will not be included although all HPV antigens would be desirable in a Savine against genital warts.

Two Savines have also been constructed for two strains of hepatitis C, a major cause of liver disease in the world. Hepatitis C is similar to HIV in the requirements for a vaccine or therapeutic. However, the major hepatitis C strains share significantly lower homology, 69-79%, with one another than do the various HIV clades. To cater for this the inventors have decided to construct two separate constructs to cater for the two major strains present in Australia, types 1a and 3a, which together cause approximately 80-95% of hepatitis C infections in this country. Both constructs will be approximately the same size as the HIV Savine but will be blended together into a single vaccine or therapy.

Overall it is believed that the Savine vaccine strategy is a generic technology likely to be applied to a wide range of human diseases. It is also believed that because it is not necessary to characterise each antigen, this technology will be actively applied to animal vaccines as well where research into vaccines or therapies is often inhibited by the lack of specific reagents, modest research budgets and poor returns on animal vaccines.

EXAMPLE 2

Hepatitis C Savine

Synthetic immunomodulatory molecules have also been designed for treating Hepatitis C. In one example, the algorithm of Figure 25 was applied to a consensus polyprotein sequence of Hepatitis C 1a to facilitate its segmentation into overlapping segments (30 aa segments overlapping by 15 aa), the rearrangement of these segments into a scrambled order and the output of Savine nucleic acid and amino acid sequences, as shown in Figure 26. Exemplary DNA cassettes (A, B and C) are also shown in Figure 26, which contain suitable restriction enzyme sites at their ends to facilitate their joining into a single expressible open reading frame.

EXAMPLE 3***Melanoma Savine***

The algorithm of Figure 25 was also applied to melanocyte differentiation antigens (gp100, MART, TRP-1, Tyros, Trp-2, MC1R, MUC1F and MUC1R) and to
5 melanoma specific antigens (BAGE, GAGE-1, gp100In4, MAGE-1, MAGE-3, PRAME, TRP2IN2, NYNSO1a, NYNSO1b and LAGE1), as shown in Figure 27, to provide separate Savine nucleic acid and amino acid sequences for treating or preventing melanoma.

EXAMPLE 4***Resolvase Repair Experiment***

10 A resolvase can be used advantageously to repair errors in polynucleotides. The following procedure outlines resolvase repair of a synthetic 340 bp fragment in which DNA errors were common.

Method

The 340 bp fragment was PCR amplified and gel purified on a 4% agarose gel.
15 After spin purifying, 10ul of the eluate corresponding to approximately 100 ng was subjected to the resolvase repair treatment. The rest of the DNA sample was stored for later cloning as the untreated control.

2 μ L of 10xPCR buffer, 2 μ L of 20 mM $MgCl_2$ and 6 μ L of MilliQ™ water (MQW) and Taq DNA polymerase were added to the 10 μ L DNA sample. The mixture
20 was subjected to the following thermal profile; 95°C for 5min, 65°C for 30min, cooled and held at 37°C. Five μ L of 10xT7 endonuclease I buffer, 8 μ L of 1/50 μ L of T7endoI enzyme stock and 17 μ L of MQW were added, mixed and incubated for 30 min. Loading buffer was added to the sample and the sample was electrophoresed on a 4% agarose gel. A faint band corresponding to the full length fragment was excised and subjected to 15 further
25 cycles of PCR. The amplified fragment was agarose gel purified and, along with the untreated DNA sample, cloned into pBluescript. Eleven plasmid clones for each DNA sample were sequenced and the number and type of errors compared (see table)

Buffers were as follows:

10x T7 endonuclease buffer

2.5ml 1M TRIS pH7.8, 0.5ml 1M MgCl₂, 25 µL 1 M DTT, 50 µL 10mg/mL BSA, 2 mL MQW made up to a total of 5 mL.

5 T7 endonuclease I stock

Concentrated sample of enzyme prepared by, and obtained from, Jeff Babon (St Vincent's Hospital) was diluted 1/50 using the following dilution buffer: 50 µL 1 M TRIS pH7.8, 0.1µL 1M EDTA pH8, 5 µL 100 mM glutathione, 50 µL 10mg/mL BSA, 2.3 mL MQW, 2.5 mL glycerol made up to a total of 5 mL.

10 Results

The results are summarised in Tables 2 and 3.

TABLE 2

TABLE 2	
Expected	Results found
A/T to G/C = 6	A/T to G/C = 1
G/C to A/T = 12	G/C to A/T = 7
A/T to deletion = 1	A/T to deletion = 1
G/C to deletion = 6	G/C to deletion = 3

TABLE 3

TABLE 3	
Expected	Results found
6/11 contained deletions	3/11 contained deletions
9/11 contained mutations	7/11 contained mutations

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SHORT SUMMARY	
Untreated	Resolvase treated
2/11 correct	3/11 correct

Discussion/Conclusion

While overall the number of correct clones obtained was not significantly different, there was a significant difference in the level of errors. This reduction in errors becomes more significant as greater numbers of long oligonucleotides are joined into the one construct *i.e.*, increasing the difference between untreated *versus* treated samples in the chance of obtaining a correct clone. It is believed that combining another resolvase such as T4 endonuclease VII may further enhance repair or increase the bias against errors.

Importantly, this experiment was not optimised *e.g.*, by using proofreading PCR enzymes or optimised conditions. Finally if the repair reaction is carried out during normal PCR, for example, by including a thermostable resolvase, it is believed that amplification of already damaged long oligonucleotides, and the normal accumulation of PCR induced errors, even using error reading polymerases during PCR, could be reduced significantly. The repair of damaged long oligonucleotides is particularly important for synthesis of long DNA fragment such as in Savines because, while the rate of long oligonucleotide damage is typically <5%, after joining 10 oligonucleotides, the error rate approaches 50%. This is true even using the best proofreading PCR enzymes because these enzymes do not verify the sequence integrity using correct oligonucleotide templates that exist as a significant majority (95%) in a joining reaction.

The disclosure of every patent, patent application, and publication cited herein is incorporated herein by reference in its entirety.

The citation of any reference herein should not be construed as an admission that such reference is available as "Prior Art" to the instant application

Throughout the specification the aim has been to describe the preferred embodiments of the invention without limiting the invention to any one embodiment or specific collection of features. Those of skill in the art will therefore appreciate that, in

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light of the instant disclosure, various modifications and changes can be made in the particular embodiments exemplified without departing from the scope of the present invention. All such modifications and changes are intended to be included within the scope of the appended claims.

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WHAT IS CLAIMED IS:

1. A synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide.
2. The synthetic polypeptide of claim 1, consisting essentially of different segments of a single parent polypeptide.
3. The synthetic polypeptide of claim 1, consisting essentially of different segments of a plurality of different parent polypeptides.
4. The synthetic polypeptide of claim 1, wherein the segments in said synthetic polypeptide are linked sequentially in a different order or arrangement relative to their linkage in said at least one parent polypeptide.
5. The synthetic polypeptide of claim 4, wherein the segments in said synthetic polypeptide are randomly rearranged relative to their order or arrangement in said at least one parent polypeptide.
6. The synthetic polypeptide of claim 1, wherein the size of an individual segment is at least 4 amino acids.
7. The synthetic polypeptide of claim 6, wherein the size of an individual segment is from about 20 to about 60 amino acids.
8. The synthetic polypeptide of claim 7, wherein the size of an individual segment is about 30 amino acids.
9. The synthetic polypeptide of claim 7, comprising at least 30% of the parent polypeptide sequence.
10. The synthetic polypeptide of claim 1, wherein at least one of said segments comprises partial sequence identity or homology to one or more other said segments.
11. The synthetic polypeptide of claim 10, wherein the sequence identity or homology is contained at one or both ends of an individual segment.

12. The synthetic polypeptide of claim 11, wherein one or both ends of said segment comprises at least 4 contiguous amino acids that are identical to, or homologous with, an amino acid sequence contained within one or more other of said segments.
13. The synthetic polypeptide of claim 10, wherein the size of an individual segment is about twice the size of the sequence that is identical or homologous to the or each other said segment.
14. The synthetic polypeptide of claim 13, wherein the size of an individual segment is about 30 amino acids and the size of the sequence that is identical or homologous to the or each other said segment is about 15 amino acids.
15. The synthetic polypeptide of claim 1, wherein an optional spacer is interposed between some or all of the segments.
16. The synthetic polypeptide of claim 15, wherein the spacer alters proteolytic processing and/or presentation of adjacent segment(s).
17. The synthetic polypeptide of claim 16, wherein the spacer comprises at least one neutral amino acid.
18. The synthetic polypeptide of claim 16, wherein the spacer comprises at least one alanine residue.
19. The synthetic polypeptide of claim 1, wherein the at least one parent polypeptide is associated with a disease or condition.
20. The synthetic polypeptide of claim 1, wherein the at least one parent polypeptide is selected from a polypeptide of a pathogenic organism, a cancer-associated polypeptide, an autoimmune disease-associated polypeptide, an allergy-associated polypeptide or a variant or derivative of these.
21. The synthetic polypeptide of claim 1, wherein the at least one parent polypeptide is a polypeptide of a virus.
22. The synthetic polypeptide of claim 21, wherein the virus is selected from a Human Immunodeficiency Virus (HIV) or a Hepatitis virus.
23. The synthetic polypeptide of claim 22, wherein the virus is a Human Immunodeficiency Virus (HIV) and the at least one parent polypeptide is selected from env, gag, pol, vif, vpr, tat, rev, vpu and nef, or a combination thereof.

24. The synthetic polypeptide of claim 1, wherein the at least one parent polypeptide is a cancer-associated polypeptide.
25. The synthetic polypeptide of claim 24, wherein the cancer is melanoma.
26. The synthetic polypeptide of claim 25, wherein the at least one parent polypeptide is a melanocyte differentiation antigen.
27. The synthetic polypeptide of claim 25, wherein the at least one parent polypeptide is a melanocyte differentiation antigen selected from gp100, MART, TRP-1, Tyros, TRP2, MC1R, MUC1F, MUC1R or a combination thereof.
28. The synthetic polypeptide of claim 25, wherein the at least one parent polypeptide is a melanoma-specific antigen.
29. The synthetic polypeptide of claim 25, wherein the at least one parent polypeptide is a melanoma-specific antigen selected from BAGE, GAGE-1, gp100In4, MAGE-1, MAGE-3, PRAME, TRP2IN2, NYNSO1a, NYNSO1b, LAGE1 or a combination thereof.
30. A synthetic polynucleotide encoding a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide.
31. A method for producing the synthetic polynucleotide encoding a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide, said method comprising:
- linking together in the same reading frame a plurality of nucleic acid sequences encoding different segments of the at least one parent polypeptide to form a synthetic polynucleotide whose sequence encodes said segments linked together in a different relationship relative to their linkage in the at least one parent polypeptide.
32. The method of claim 31, further comprising fragmenting the sequence of a respective parent polypeptide into fragments and linking said fragments together in a different relationship relative to their linkage in a respective parent polypeptide sequence.

33. The method of claim 32, wherein the fragments are randomly linked together.
34. The method of claim 31, further comprising reverse translating the sequence of a respective parent polypeptide or a segment thereof to provide a nucleic acid sequence encoding said parent polypeptide or said segment.
35. The method of claim 34, wherein an amino acid of a respective parent polypeptide sequence is reverse translated to provide a codon, which has higher translational efficiency than other synonymous codons in a cell of interest.
36. The method of claim 35, wherein an amino acid of said parent polypeptide sequence is reverse translated to provide a codon which, in the context of adjacent or local sequence elements, has a lower propensity of forming an undesirable sequence that is refractory to the execution of a task.
37. The method of claim 35, wherein an amino acid of said parent polypeptide sequence is reverse translated to provide a codon which, in the context of adjacent or local sequence elements, has a lower propensity of forming an undesirable sequence selected from a palindromic sequence or a duplicated sequence, which is refractory to the execution of a task selected from cloning or sequencing.
38. The method of claim 31, further comprising linking a spacer oligonucleotide encoding at least one spacer residue between segment-encoding nucleic acids.
39. The method of claim 38, wherein spacer oligonucleotide encodes 2 to 3 spacer residues.
40. The method of claim 38 or claim 39, wherein the spacer residue is a neutral amino acid.
41. The method of claim 38 or claim 39, wherein the spacer residue is alanine.
42. The method of claim 31, further comprising linking in the same reading frame as other segment-containing nucleic acid sequences at least one variant nucleic acid sequence which encodes a variant segment having a homologous but not identical amino acid sequence relative to other encoded segments.

43. The method of claim 42, wherein the variant segment comprises conserved and/or non-conserved amino acid differences relative to one or more other encoded segments.
44. The method of claim 43, wherein the differences correspond to sequence polymorphisms.
45. The method of claim 44, wherein degenerate bases are designed or built in to the at least one variant nucleic acid sequence to give rise to all desired homologous sequences.
46. The method of claim 31, further comprising optimising the codon composition of the synthetic polynucleotide such that it is translated efficiently by a host cell.
47. A synthetic construct comprising a synthetic polynucleotide encoding a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide, wherein said synthetic polynucleotide is operably linked to a regulatory polynucleotide.
48. The synthetic construct of claim 47, further including a nucleic acid sequence encoding an immunostimulatory molecule.
49. The synthetic construct of claim 48, wherein the immunostimulatory molecule comprises a domain of an invasin protein (Inv).
50. The synthetic construct of claim 48, wherein the immunostimulatory molecule comprises the sequence set forth in SEQ ID NO: 1467 or an immune stimulatory homologue thereof.
51. The synthetic construct of claim 48, wherein the immunostimulatory molecule is a T cell co-stimulatory molecule.
52. The synthetic construct of claim 48, wherein the immunostimulatory molecule is a T cell co-stimulatory molecule selected from a B7 molecule or an ICAM molecule.
53. The synthetic construct of claim 48, wherein the immunostimulatory molecule is a B7 molecule or a biologically active fragment thereof, or a variant or derivative of these.

54. The synthetic construct of claim 48, wherein the immunostimulatory molecule is a cytokine selected from an interleukin, a lymphokine, tumour necrosis factor or an interferon.

55. The synthetic construct of claim 48, wherein the immunostimulatory molecule is an immunomodulatory oligonucleotide.

56. An immunopotentiating composition, comprising an immunopotentiating agent selected from the synthetic polypeptide of claim 1, the synthetic polynucleotide of claim 30 or the synthetic construct of claim 47, together with a pharmaceutically acceptable carrier.

57. The composition of claim 56, further comprising an adjuvant.

58. A method for modulating an immune response, which response is preferably directed against a pathogen or a cancer, comprising administering to a patient in need of such treatment an effective amount of an immunopotentiating agent selected from the synthetic polypeptide of claim 1, the synthetic polynucleotide of claim 30, the synthetic construct of claim 47, or the composition of claim 56.

59. A method for treatment and/or prophylaxis of a disease or condition, comprising administering to a patient in need of such treatment an effective amount of an immunopotentiating agent selected from selected from the synthetic polypeptide of claim 1, the synthetic polynucleotide of claim 30, the synthetic construct of claim 47, or the composition of claim 56.

60. A computer program product for designing the sequence of a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide, said program product comprising:

- code that receives as input the sequence of said at least one parent polypeptide;
- code that fragments the sequence of a respective parent polypeptide into fragments;
- code that links together said fragments in a different relationship relative to their linkage in said parent polypeptide sequence; and

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- a computer readable medium that stores the codes.

61. The computer program product of claim 60, further comprising code that randomly rearranges said fragments.

62. The computer program product of claim 60, further comprising code that links the sequence of a spacer residue to the sequence of said at least one parent polypeptide or to said fragments.

63. A computer program product for designing the sequence of a synthetic polynucleotide encoding a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide, comprising:

- code that receives as input the sequence of at least one parent polypeptide;
- code that fragments the sequence of a respective parent polypeptide into fragments;
- code that reverse translates the sequence of a respective fragment to provide a nucleic acid sequence encoding said fragment;
- code that links together in the same reading frame each said nucleic acid sequence to provide a polynucleotide sequence that codes for a polypeptide sequence in which said fragments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide sequence; and
- a computer readable medium that stores the codes.

64. The computer program product of claim 63, further comprising code that randomly rearranges said nucleic acid sequences.

65. The computer program product of claim 64, further comprising code that reverse translates an amino acid of a respective parent polypeptide sequence to provide a codon, which has higher translational efficiency than other synonymous codons in a cell of interest.

66. The computer program product of claim 63, further comprising code that reverse translates an amino acid of a respective parent polypeptide sequence to provide a codon

which, in the context of adjacent or local sequence elements, has a lower propensity of forming an undesirable sequence that is refractory to the execution of a task.

67. The computer program product of claim 63, further comprising code that links a spacer oligonucleotide to one or more of said nucleic acid sequences.

68. A computer for designing the sequence of a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide, wherein said computer comprises:

- (a) a machine-readable data storage medium comprising a data storage material encoded with machine-readable data, wherein said machine-readable data comprise the sequence of at least one parent polypeptide;

- (b) a working memory for storing instructions for processing said machine-readable data;

- (c) a central-processing unit coupled to said working memory and to said machine-readable data storage medium, for processing said machine readable data to provide said synthetic polypeptide sequence; and

- (d) an output hardware coupled to said central processing unit, for receiving said synthetic polypeptide sequence.

69. The computer of claim 68, wherein the processing of said machine readable data comprises fragmenting the sequence of a respective parent polypeptide into fragments and linking together said fragments in a different relationship relative to their linkage in the sequence of said parent polypeptide.

70. The computer of claim 68, wherein the processing of said machine readable data comprises randomly rearranging said fragments.

71. The computer of claim 68, wherein the processing of said machine readable data comprises linking the sequence of a spacer residue to the sequence of said at least one parent polypeptide or to said fragments.

72. A computer for designing the sequence of a synthetic polynucleotide encoding a synthetic polypeptide comprising a plurality of different segments of at least one parent polypeptide, wherein the segments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide to impede, abrogate or otherwise alter at least one function associated with the parent polypeptide, wherein said computer comprises:

(a) a machine-readable data storage medium comprising a data storage material encoded with machine-readable data, wherein said machine-readable data comprise the sequence of at least one parent polypeptide;

(b) a working memory for storing instructions for processing said machine-readable data;

(c) a central-processing unit coupled to said working memory and to said machine-readable data storage medium, for processing said machine readable data to provide said synthetic polynucleotide sequence; and

(d) an output hardware coupled to said central processing unit, for receiving said synthetic polynucleotide sequence.

73. The computer of claim 72, wherein the processing of said machine readable data comprises fragmenting the sequence of a respective parent polypeptide into fragments, reverse translating the sequence of a respective fragment to provide a nucleic acid sequence encoding said fragment and linking together in the same reading frame each said nucleic acid sequence to provide a polynucleotide sequence that codes for a polypeptide sequence in which said fragments are linked together in a different relationship relative to their linkage in the at least one parent polypeptide sequence.

74. The computer of claim 72, wherein the processing of said machine readable data comprises randomly rearranging said nucleic acid sequences.

75. The computer of claim 72, wherein the processing of said machine readable data comprises reverse translating an amino acid of a respective parent polypeptide sequence to provide a codon, which has higher translational efficiency than other synonymous codons in a cell of interest.

76. The computer of claim 72, wherein the processing of said machine readable data comprises reverse translating an amino acid of a respective parent polypeptid sequence to provide a codon which, in the context of adjacent or local sequence elements, has a lower propensity of forming an undesirable sequence that is refractory to the execution of a task.

77. The computer of claim 72, wherein the processing of said machine readable data comprises linking a spacer oligonucleotide to one or more of said nucleic acid sequences.

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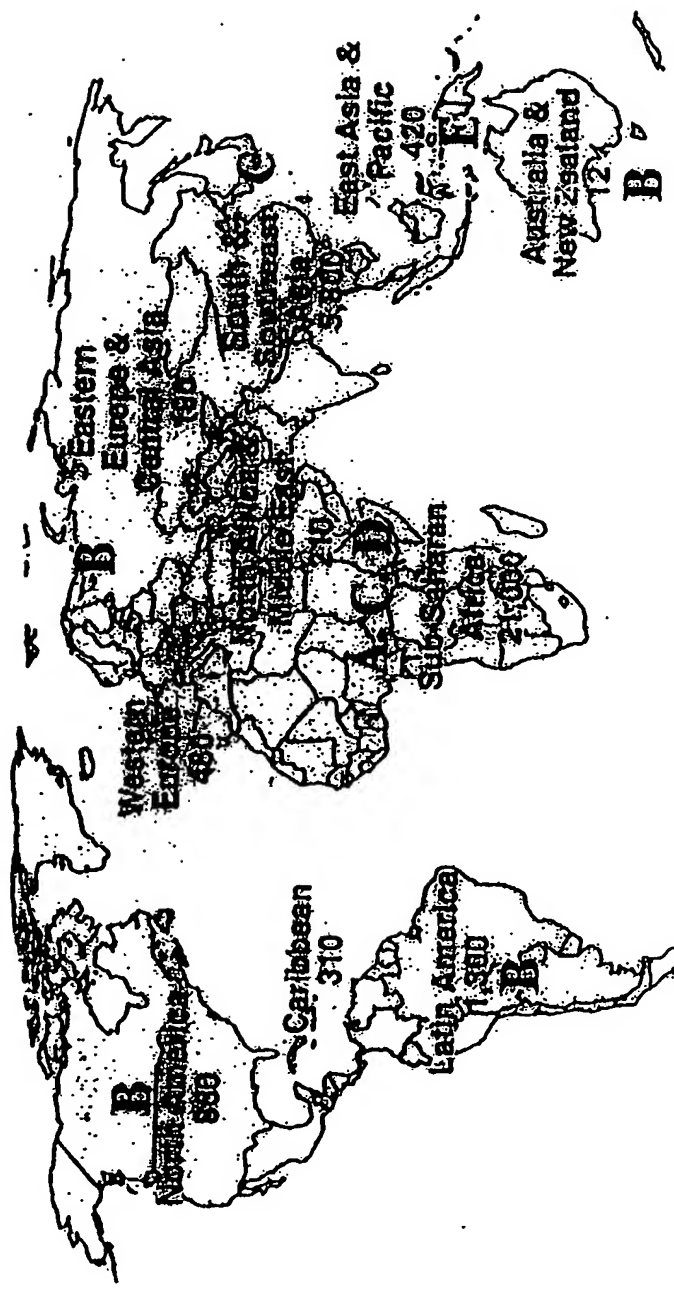


FIGURE 1

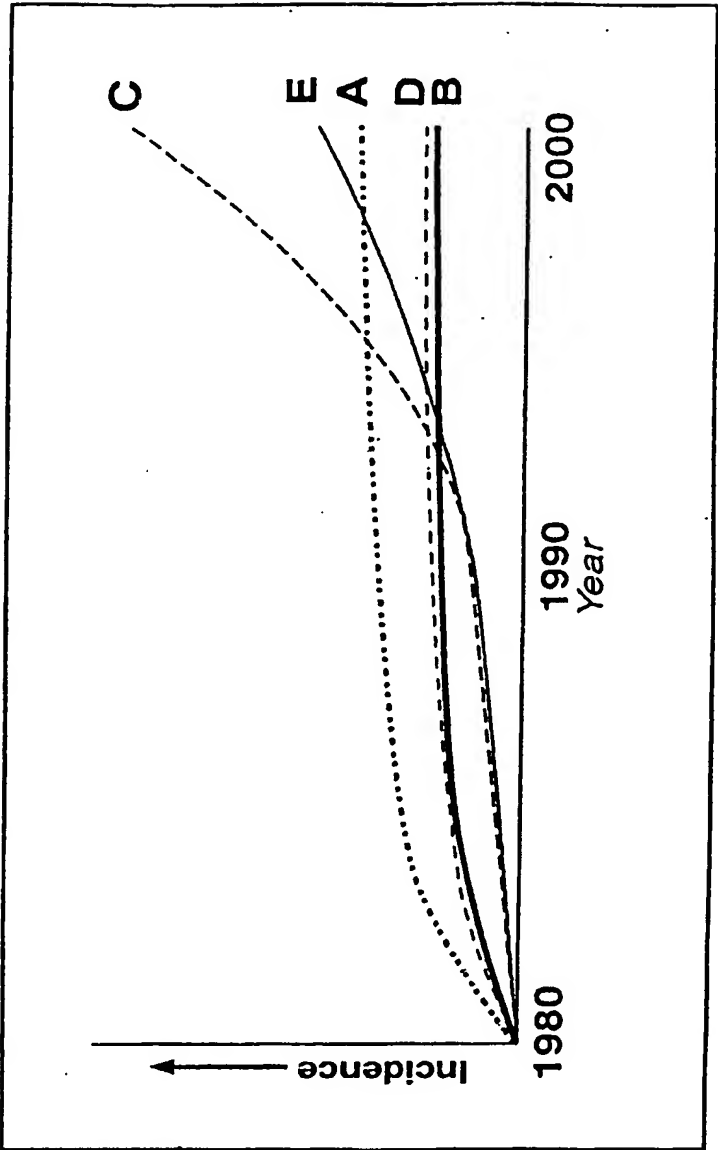


FIGURE 2

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p17 ->	/<-	nls	->/
/<-	membrane binding	->/	
DESIGNED SEQ	MGARASVLSGGKLDawEKIRLRPGGKKKKYKMHVWASRELERPALNPGLLETAEGCQQLIEQLQSALKT	70	
MUTATED AAs	R E RL I S S K G P Q		
E-ISOLATE	MGARASVLSGGKLDawEKIRLRPGGKKKKYKMHVWASRELERPALNPGLLETAEGCQQLIEQLQSTLKT	70	
CONSENSUS-A	mGARASvLsggkLDawekIrLRPgGkKkYrIhHlvwAsreLerPalnPslLeTaegcgqimeQlqsalkT	70	
CONSENSUS-B	-----e-r-----k-i-----v-g---s---R--lg---ps-q-	70	
CONSENSUS-C	-----i-x-----?-----h-Mi-----g---s---k--ik---P--Q-	69	
CONSENSUS-D	-----?-----?-----i-----G---s---k--ig---P--iq-	68	
CONSENSUS-F	-----?-----?-----?-----i-g---s---k--ig---pS-Q-	70	
CONSENSUS-G	-----?-----?-----?-----G---T-----?---P?--Q-	63	
CONSENSUS-H	-----?-----?-----?-----?---?---L-?I---P---	64	
CONSENSUS-O	-----T-S-----?---S---?-----?---C---?---E?LLQ---EP---	62	
CONSENSUS-CPZ	---?---?---?---?---?---?---M?---?---?---?---?---?K?---?P?---?---	42	
/<- nls ->/			
DESIGNED SEQ	GSEELKSLYNTIATLMCVHORIEVKDTKEALDKIEEQQKSQOK.....TQAAAA..DT.GS...SSKV		
MUTATED AAs	T R F V D R V N K N Q		
E-ISOLATE	GSEELKSLYNTIATLMCVHORIEVKDTKEALDKIEEQQKSQOK.....TQAAAA..DT.GS...SSKV		
CONSENSUS-A	g?eElkSLfNtvatLycvHqrIdvkdTKeAldkiEeignKskgk?????tqaaa..?T.gs?..sskv	126	
CONSENSUS-B	-s---x-y-----e-----E---k-----a---?d---n-??-q-	128	
CONSENSUS-C	-T---r-?-----?e-x-----E---Q-----k---ad?..k.....	120	
CONSENSUS-D	-s---e-?-----e-e-----e-m-E---k-----a---t---D---rn---Q-	125	
CONSENSUS-F	-S---r-y---v---f---vE-----L-E---q-----?---dK.....	123	
CONSENSUS-G	-T---?---?---?---?---e-----eEV-Ka-kn-Q-----?---?---e?..n---q-	110	
CONSENSUS-H	-T---Q---LL-?-----?---?---?---?Q?---T?..DK.??..??-?	106	
CONSENSUS-O	-S??-?---W-AI?V-W---W---?I?---QQ-IQ-LK-V.M?-RKS...A-AAKE.....?RQ?	106	
CONSENSUS-CPZ	?S????-?V-W-?---?V-W-?---?V-W-?---?V-W-?---?V-W-?---?V-W-?---?V-W-?	61	
p17 \ / p24			
DESIGNED SEQ	....SQNYPIVONAQGMVHOPLSPRTLNAWVKVIEEKGPNPEVIMPFALSEGATPODLNMMMLNIVGGH		
MUTATED AAs	L AI V A S T T T		
E-ISOLATE	....SQNYPIVONAQGMVHOPLSPRTLNAWVKVIEEKGPNPEVIMPFALSEGATPODLNMMMLNIVGGH		
CONSENSUS-A	????SQNYPIVONAggOm?hQ?LSPRTLNAWVKVIEEkaFspEVIPmFsaLSEGATpQdLNMMLNivGgH	190	
CONSENSUS-B	-----l---v---ai-----v-----T---T---	194	
CONSENSUS-C	-----L---v---ai-----?---T-----T---T---	185	
CONSENSUS-D	-----L---v---ai-----t---T---	191	
CONSENSUS-F	-----l---v---i-----T---T---	188	
CONSENSUS-G	-----i-----v-----t---T---	174	
CONSENSUS-H	-----?V---AI-----V-----A---?	170	
CONSENSUS-O	-----?---?---V---AI-----AV---N---I---M-----??Y-I-T---AI---	168	
CONSENSUS-CPZ	---?---?---?---?---?---?---V---?---?---?---?---?---?---?---?---?---?	107	
DESIGNED SEQ	QAAMQMLKETINEEAAENDRVHPVHAGPIPPGOMREPRGSDIAGTTSTLQEQIGWMTN...NPPIPVGD I		
MUTATED AAs	D I VA I A S V B		
E-ISOLATE	QAAMQMLKETINEEAAENDRVHPVHAGPIPPGOMREPRGSDIAGTTSTLQEQIGWMTN...NPPIPVGD I		
CONSENSUS-A	QAAMQMLKdtInEAAewDr?HPVhAgPippgQmREPrGSDIAGtTStlqEqigwmts...NPPiPVGD I	256	
CONSENSUS-B	-----e-----l-----a-----n-----e-----	261	
CONSENSUS-C	-----l-----vA-----a---?-----	251	
CONSENSUS-D	-----E-----l-----A-----?-----e-----	257	
CONSENSUS-F	-----L---q-----i-----q-----v---e-----	255	
CONSENSUS-G	-----I---?Q-----I---?-----R-----e-----	239	
CONSENSUS-H	-----?---?---?---?---?---?---A---?---?---?---	233	
CONSENSUS-O	-G-L-V---EV---?---T---P?---L---I---T-----Q---?---T-R.??-??-	229	
CONSENSUS-CPZ	-G---V---EV-----L---T---?---?---L---?---?---?---?---?---?---?---	160	
/<- MHR ->/			

FIGURE 3

SUBSTITUTE SHEET (RULE 26)

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	p24 \/ \/ 'p2' \/ p7	Zn-motif /<-
DESIGNED SEQ	SILKALGTGATLEEMMTACQGVGGPSHKARVLAEAMSQA...TH.AN...IMMQRGNF.KGQKRIKCFN	
MUTATED AAs	T R P S G V NN R P V	
ISOLATE-E	SILKALGTGATLEEMMTACQGVGGPSHKARVLAEAMSQA...QH.AN...IMMQRGNF.KGQTR.IKCFN	
CONSENSUS-A	sILraLg?gAtLeEMMTacOgVggPgHKArvLAEAmSqv...q???n??iMmQrGnf.rgqkr?iKCFN	38
CONSENSUS-B	T--K--Pa-----tn-s.at?-----n-rKty--	39
CONSENSUS-C	T--P--s-----s-----a...nn-----s--K-p--iv--	38
CONSENSUS-D	t--K--P?-----s-----a...tn.s.ta-----K-prki--	39
CONSENSUS-F	T--K--P-----a...TN.-?a-----ks--K--R-iv--	38
CONSENSUS-G	T--?--P-----?-----A...SG.-A-A.-?--K??-K-P??-?	36
CONSENSUS-H	?--?--SI-----?--?-----?..TN.-?A.-?--K--K--R-I?--	35
CONSENSUS-O	Q--K?--P?-----V-----T--??--A?AQQDLKGGYTA.VF---QN.P?R-G----	35
CONSENSUS-CPZ	?--K-----?-----?-----?-----?Q.-?-.-VF?--?G??-?-----	26
	pol cds ->	
	Zn-motif ->/ /<-Zn-motif ->/ p7 \/ 'p1' \/ p6	
DESIGNED SEQ	CGKEGHLARNCRAPRKKGCKWCKGKEGHQMKDCT..E.RQANFLGKIWPSNKG.RPGNFPQSKP.....	
MUTATED AAs	I K R H L R	
ISOLATE-E	CGKEGHLARNCRAPRKKGCKWCKGKEGHQMKDCT..E.RQANFLGKIWPSNKG.RPGNFPQSKP.....	
CONSENSUS-A	CGkEGHlArNCrAPrKKGcWcKcGkEGHqMkDCT.?e.rQANFlgkiwPsSkg.RPgNfPqSRp.....	443
CONSENSUS-B	-----i-k-----h-----l-----???????	453
CONSENSUS-C	-----i-----?-----?-----L-----???????	439
CONSENSUS-D	-----i-k-----h-----l-----	449
CONSENSUS-F	-----i-k-----r-----n-----L-----	445
CONSENSUS-G	-----?-----?-----?-----H-----L-?-?	414
CONSENSUS-H	-----?-----?-----?-----L-----	406
CONSENSUS-O	-----I-?-?-?-?-Q-----?..NG?-----Y--PGGT-----YV-???	411
CONSENSUS-CPZ	-----?-----K--R--R--Q-----?--??-??V-----??-??-?-V-???	306
	vpr binding	vpr binding p6 terminus / (80%)
	/<-->/ \/ (minor) (minor) \/ /<- ->/	
DESIGNED SEQ	.....EPTAPPAE.....NF.GFGEETT.PS....PKQEQKD....KEHYPPSASLKSFLGNDPLSQ	
MUTATED AAs	S R Q P L L S	
ISOLATE-E	.....EPTAPPAE.....NW.GMGEE.....QKD....KEHPPPSVSLKSFLGNDPLSQ	
CONSENSUS-A	.....EPTAPPAE.....?f?gmgeeit.s?....pkqeqkd...??ke??ppl?slKSLFGNDplSQ	485
CONSENSUS-B	??..???-e-----s-.rf--t-tps???q--pi-----ly?--a--r-----s--\$	500
CONSENSUS-C	???????-??????S-.rf--t-pa-----p--??-?-?-t-----x	479
CONSENSUS-D	-----S-.F-----Ps....q-----??--ly--a-----	495
CONSENSUS-F	-----s-.F?-----PS....egly--a-----	482
CONSENSUS-G	-----?-----?..???-?..?S....P??....LY?-----	440
CONSENSUS-H	-----S-.P--M-.P-----??-?-?-?	436
CONSENSUS-O	-----?--S--M-----?VK.QO...EN--?--G.--?--LY.-FA-----T-Q\$	444
CONSENSUS-CPZ	-----I-----Y.??Q--?K.-?....?--??-??L--?-----?--?	333

CONSENSUS A-CPZ FROM LOS ALAMOS HIV SEQUENCE DATABASE
ISOLATE-E SEQ FROM ISOLATE 93TH253 THAILAND

Underlined AA are not present in all overlapping segments

FIGURE 3 (Cont)

SUBSTITUTE SHEET (RULE 26)

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DESIGNED SEQ	FFRE.NLAFQOGKAREP.....SSE..QTGANSSASRKLGDGGG.....AER..Q	
MUTATED AAS	P E P R PT D	
ISOLATE-E	FFRE.NLAFQOGKAREP.....SSE..QTGANSSASRKLGDGGG.....AER..Q	
CONSENSUS-A	FFRE.NLAFQOGKAREP.....SSE..QT??NS?TSR?LWDGG?D??L?...??G?E?..Q	35
CONSENSUS-B	----d--p--k--e-????????????--Ra--p--r--E--qVw--r--nnS--S??-EA--adr--	49
ISOLATE-C	----T--K--E--P--RA--P--T--QV.RGSN....T.PSEAGAER..Q	
CONSENSUS-D	----d--P--K--GEL.....RA--P--E--RVW--r--NP--S....eT--A--R--	48
CONSENSUS-O	---.?--SGGH--QL.....CA..TS--PI--P--?.....GSE.....GT--ES?---G??	35
CONSENSUS-U	----P--K--E--P--RA--P--E--RVW--G--K--T--S....ET--A--R--	48
CONSENSUS-CPZ	---L-?????????L.....CA-?????--?--?--?--?--?--?--?--?--?--?--?	13
protease V <- gag cds end		
DESIGNED SEQ	GT..SSSFSPQITLWQRPLVTIKIGGQLKEALLDTGADDTVLEDINLPGKWKPK?MIGGIGGFIKVRQYD	
MUTATED AAS	LN V I EM R	
ISOLATE-E	GT..SSSFSPQITLWQRPLVTIKIGGQLKEALLDTGADDTVLEDINLPGKWKPK?MIGGIGGFIKVRQYD	
CONSENSUS-A	G?..??SF?FPQITLWQRPLVTI?GQLIEALLDTGADDTVLEDINLPGKWKPK?IGGIGGFIKVRQYD	96
CONSENSUS-B	---tV--s-----ik-g--K-----eM--r--M-----	116
ISOLATE-C	---LM-----IK-G--K-----E--M-----	
CONSENSUS-D	---TV--n-----IK-G--K-----Em--M-----	115
CONSENSUS-O	R...A??CL--P--D--I--A--VG--H--C--?-----NN--Q--E--?--M-----KE--?	94
CONSENSUS-U	---IV--S-----V--RVG--K-----E--M-----	115
CONSENSUS-CPZ	?-?	55
protease \ / p66, p51		
DESIGNED SEQ	QILIEICGKKAIGTVLVGPTFVNIIGRNMLTQIGCTLNFPISPIDTVPVKLPKMGDPKVKQWPLTEEKI	
MUTATED AAS	I H L L R E	
ISOLATE-E	QILIEICGKKAIGTVLVGPTFVNIIGRNMLTQIGCTLNFPISPIDTVPVKLPKMGDPKVKQWPLTEEKI	
CONSENSUS-A	QILIEICGKKAIGTVLVGPTFVNIIGRNMLTQIGCTLNFPISPIDTVPVKLPKMGDPKVKQWPLTEEKI	164
CONSENSUS-B	---H--A-----L-----G-----	186
ISOLATE-C	---I-----A-----M-----L--R-----G-----	
CONSENSUS-D	---?--A-----L-----G-----	184
CONSENSUS-O	NVTV--??-?EVQ-----?--I--GL-----AP-----G-----S?---	159
CONSENSUS-U	---A--I-----G-----R-----	185
CONSENSUS-CPZ	?V?-?-??R?V?-----?--?--L--?--?--?--?--?--?--?--?--?--S?---	106
M41L D67N | K70R		
DESIGNED SEQ	KALTEICKEMELEGKISKIGPENFYNTVPVFAIKKDDSTKWRKLVDPRELNKRTQDFWEVQLGIPHAGLAK	
MUTATED AAS	A T K R I	
ISOLATE-E	KALTEICKEMELEGKISKIGPENFYNTVPVFAIKKDDSTKWRKLVDPRELNKRTQDFWEVQLGIPHAGLAK	
CONSENSUS-A	KALT?IC?EMEREGKISKIGPENFYNTVPVFAIKKDDSTKWRKLVDPRELNKRTQDFWEVQLGIPH?AGLAK	231
CONSENSUS-B	---vE--T-----P-----	256
ISOLATE-C	---A--E--Q-----R-----P-----	
CONSENSUS-D	---E--T-----R-----I-----P-----	254
CONSENSUS-O	E--A--Q--Q-----R-----I-----?-----?-----PG---	227
CONSENSUS-U	---E--KD-----L-----N-----P-----	255
CONSENSUS-CPZ	?--?E--??-?	164
polymerase motif		
DESIGNED SEQ	KKKSVTVLVDGDAYFSVPLDESFRKYTAFTIPSINNTPGIRYQYNVLPQGWKGSFAIFQSSMTKILEPF	
MUTATED AAS	KD T P PQ	
ISOLATE-E	KKKSVTVLVDGDAYFSVPLDESFRKYTAFTIPSINNTPGIRYQYNVLPQGWKGSFAIFQSSMTKILEPF	
CONSENSUS-A	KKKSVTVLVDGDAYFSVPLD??FRKYTAFTIPS?NNTPG?RYQYNVLPQGWKGSF?IPQ?SMTKILEPF	295
CONSENSUS-B	---kd-----i-----i-----A--s-----	326
ISOLATE-C	---EG-----T-----I-----P--S--PQ---	
CONSENSUS-D	---eD-----I-----I-----A--S-----	324
CONSENSUS-O	Q?Q-----C--PD-----V-----A--S-----D---	295
CONSENSUS-U	---ED-----I-----I-----A--S-----	325
CONSENSUS-CPZ	?-----?-----D-----?-----?-----?-----?	225

FIGURE 4

SUBSTITUTE SHEET (RULE 26)

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DESIGNED SEQ	OPIELPEKDSWTVDIQKLVGKLNWASQIYAGIKVKQKLCCLRGTKALTDIVPLTEEAELELENREI...	
MUTATED AAS	V E P R A E T A	
ISOLATE-E	OPIELPEKDSWTVDIQKLVGKLNWASQIYAGIKVKQKLCCLRGTKALTDIVPLTEEAELELENREI...	
CONSENSUS-A	QP??LPEKDSWTVDIQKLVGKLNWASQIYAGIK?KQK?LLRGAKALTDIV?LTEAELELAENREI...	421
CONSENSUS-B	--Iv-----V-----k-----t-----Evip-----	464
ISOLATE-C	--IQ-----P--VR--K-----T-----	
CONSENSUS-D	--sIk--E-----p--Vr--K--T--EviP-----	462
CONSENSUS-O	--?IO--?--?V-----?-----Q--RV?E--K--I--T--S--EV--P--S?-----E--?..	419
CONSENSUS-U	--IQ--D--E-----P--V--K-----P--A-----	463
CONSENSUS-CPZ	--?I-----??--P-----I--?--?--?--?--?--?--?--?--?	329
DESIGNED SEQ	.LRFVHGVIYDPSKDLVAEVQKQGQDQNTYQIYQEPFNKLTGKYSRKRSHTNDVRQLTEVVQKIATE	
MUTATED AAS	K I I G P F(error) A M G K A A V	
ISOLATE-E	.LRIPVHGVIYDPSKDLVAEVQKQGQDQNTYQIYQEPFNKLTGKYSRKRSHTNDVRQLTEVVQKIATE	
CONSENSUS-A	.LK?PVHGVIYDP?KDLVAE?QKQGQDQNTYQIYQEPFNKLTGKYA?KRSHTNDVRQLTEVVQKV??E	484
CONSENSUS-B	--e-----s--i--i--g-----r--G-----A--iat-	533
ISOLATE-C	--E--P--S--I--I--N--P--F--F--T-----A--IAL-	
CONSENSUS-D	--E-----S--I--i--hG-----R--G-----a--a--IsT-	531
CONSENSUS-O	--Q--D--WV?I--?--?--?--?--?EH-----?RQAS--IR--A--?--SO-	479
CONSENSUS-U	--E-----S--I--I--G-----QY-----RIK-----A--IAQ-	532
CONSENSUS-CPZ	??-??-?	367
DESIGNED SEQ	SIVINGKTPKPLPIQRETWETWMEYNQATNIPENEFVNTPLVLKLYQLEKDPVGAETFFYVDGAASR	
MUTATED AAS	K K A TD E A V N	
ISOLATE-E	SIVINGKTPKPLPIQRETWETWMEYNQATNIPENEFVNTPLVLKLYQLEKDPVGAETFFYVDGAASR	
CONSENSUS-A	SIVINGK?PKPLPIQ?ETWE?WMEYNQATNIPENEFVNTPLVLKLYQLEKDPY?GAETFFYVDGAASR	550
CONSENSUS-B	-----t--k-----K-----A--TD-----E--A--V-----	602
ISOLATE-C	-----T-----K-----A--TD-----E--A--V-----	
CONSENSUS-D	-----T-----K-----T--?-----E--I-----	600
CONSENSUS-O	?--?--L--?--VTR--T--A?-----S--I--?--?E--?-----?	541
CONSENSUS-U	-----T-----K-----A--T-----TE--V-----	602
CONSENSUS-CPZ	-----?-----?--?--?A--?-----?-----?--?--?--?--?--?--?--?--?	416
DESIGNED SEQ	ETKLGKAGYVTDGRQKVISLTETTNOKTELHAIHLALQDSGSEVNIIVTDSQYALGIIQAQPDRESEVV	
MUTATED AAS	IV D Q Q L L K L	
ISOLATE-E	ETKLGKAGYVTDGRQKVISLTETTNOKTELHAIHLALQDSGSEVNIIVTDSQYALGIIQAQPDRESEVV	
CONSENSUS-A	ETK?GAGYVTDGRQKVVSLTETTNOKTELHAIHLALQDSGSEVNIIVTDSQYALGIIQAQPDRESE?V	618
CONSENSUS-B	---l-----d-----q-----l-----k-----l-	672
ISOLATE-C	---I-----I-----Q--Q-----L--K--F--	
CONSENSUS-D	---L-----P--D-----Q--N-----L-----K--L-	670
CONSENSUS-O	?--L-----EQ--K--?IK--?-----A--M--?L?--KB?-----?--?--SS--TQ--?--PI-	602
CONSENSUS-U	---K-----Q-----Q-----K-----I-	672
CONSENSUS-CPZ	??-?-----?--?--?--?A--?-----QA--?--?L?--?--?--?--?--?--?--?--?L-	459
DESIGNED SEQ	SQIIEELIKKEKVYLSWVPAHKGIGGNEQVDKLVISGIRKVLFLDGINKAQEEHRYHSNNRTMASDFNL	
MUTATED AAS	N K R A SA D K NE	
ISOLATE-E	SQIIEELIKKEKVYLSWVPAHKGIGGNEQVDKLVISGIRKVLFLDGINKAQEEHRYHSNNRTMASDFNL	
CONSENSUS-A	NQIIEKLI?K?KVYLSWVPAHKGIGGNEQVDKLV?GIRKVLFLDGIDKAQE?HB?YH?NN?AMASDFNL	681
CONSENSUS-B	s---q--K-E--a-----a-----e--K--s--r-----	742
ISOLATE-C	---Q--S-ER-----S-----E--K--S--R--NE--I	
CONSENSUS-D	s---Q--K-E--A-----Q-----E--K--N--R-----	740
CONSENSUS-O	Q---E--TK-E?--T-----KI--KD--R--E---Q--D--K--S---L--?--G-	669
CONSENSUS-U	---Q--Q--D-----S-----E--K--S--R-----	742
CONSENSUS-CPZ	??-??-K?ETI-----?-----?-----?--?--?--?--?--?	510
DESIGNED SEQ	PPIVAKEIVANCDCOLKGEAMHGQVDCSPGINQLDCTHLEGKVILVAVHVASGYIEAEVIPAETGQETA	
MUTATED AAS	P S I N I	

FIGURE 4 (Cont)

SUBSTITUTE SHEET (RULE 26)

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ISOLATE-C	--L-----R-----N---A---GIG-----E-	
CONSENSUS-D	--1-----V-----A---GIK-----D-	880
CONSENSUS-O	--L---A-----P---??M---A---??IOH-----A---S---Q---D-	798
CONSENSUS-U	-----V-----A---IK-----E-	882
CONSENSUS-CPZ	--L---?-----T-----?-----A---?I-----?--?--?--?--D-	631

DESIGNED SEQ AEHLKTAVQMAVPIHNPKRKGIGGYSAGERIIDIIATDIQTKELQKQITKIQNFRVYYRDSRDPINWGP
 MUTATED AAS R V S N L L

ISOLATE-E	AEHLKTAVQMAVPIHNPKRKGIGGYSAGERIIDIIATDIQTKELQKQITKIQNFRVYYRDSRDPINWGP	
CONSENSUS-A	AEHLKTAVQMAVPIHNPKRKGIGGYSAGERIIDIIA?DIQTKELQKQI?KIQNFRVYYRDSRDPINWGP	880
CONSENSUS-B	-----v-----t-----T-----l-----	952
ISOLATE-C	-----R-----S-----N---L-----	
CONSENSUS-D	-----T-----i-----	950
CONSENSUS-O	---?-----V-----T---?--L-SQ---T---L-?N-----	865
CONSENSUS-U	-----M---T-----T-----N-----	952
CONSENSUS-CPZ	--?-----?-----T?--?--?--T---??--?--L-?-?-?-?-----	687

vif cds ->
 DESIGNED SEQ AKLLNKGEGAVVIQNSDIKVVPRRKAKIIRDYGKQMGDDCVAGRQDED
 MUTATED AAS A S

ISOLATE-E	AKLLNKGEGAVVIQNSDIKVVPRRKAKIIRDYGKQMGDDCVAGRQDED	
CONSENSUS-A	AKLLNKGEGAVVIQNSDIKVVPRRKAKIIRDYGKQMGDDC?AGRQDED	929
CONSENSUS-B	-----V-s-----	1002
ISOLATE-C	-----A---V-----	
CONSENSUS-D	-----V-----V-S-----	1000
CONSENSUS-O	-Q-----KG-----T-SM-N--T-SESMBQGEIP	925
CONSENSUS-U	-----V--G---KHGTAN	1008
CONSENSUS-CPZ	-?-----QGEI-----V-S--N--KHGTAN	742

CONSENSUS A-CPZ FROM LOS ALAMOS HIV SEQUENCE DATABASE
 ISOLATE-C FROM GENBANK U46016 HIV-1 SUBTYPE C (ETHIOPIA)
 ISOLATE-E FROM GENBANK U51189 HIV-1 SUBTYPE E ISOLATE 93TH253 (THAILAND)

FIGURE 4 (Cont)

```
<- pol cds
```

vpr cds ->

SUBSTITUTE SHEET (RULE 26)

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      <- vif cds                                LR domain
      /<-          oligomerization          ->/          /<-

DESIGNED SEQ MEQ AP EDQGPQREPYNEWALELLEELKOEAVRHFPRLHNLGQYIYETYGDTWSGVEALIRTLQQL
MUTATED AAs      SS      T      H      G      H      E      I

ISOLATE-E MEQ AP EDQGPQREPYNEWALELLEELKQRAVRHFPRLHNLGQYIYETYGDTWSGVEALIRTLQQL

CONSENSUS-A ME?..AP.EDQGPQREP??E??LELLEELKHE?VRHFPR?NLHGLGQHIIY?TYGDTWEGV?AIIRILQQL      58
CONSENSUS-B --q??--?-----yN-Wt-----?--A-----i---?-----E-----a--E-----      65
ISOLATE-C MEQ AP EDQSSQREPYNEWLELLEELKNEAVRHFPRLHNLGQYIYNNYGDWEGVEAIIRILQQL
CONSENSUS-D --Q...-----YN-Wt-----S-A-----I---S---?--E-----?--E-?-----      64
CONSENSUS-O --Q...-n--a--fN-Wt-----?--A-----p--a--y--E-----m-----      66
CONSENSUS-U --Q...-A-----HN-WT-----Q-A-----I---S-----E-----E---S-----      67
CONSENSUS-CPZ --Q...-?-?-?-?-W---T---?-N-A-----?P?-????-???-?-???????-???????-??      33

      LR domain ->/ tat cds ->

DESIGNED SEQ MPFH FRIGCQHSRIGIL RQRR RRGASRS
MUTATED AAs L V      R      I
              T

ISOLATE-E MPFH FRIGCQHSRIGIL RQRR RRGASRS

CONSENSUS-A LF?H.FRIGCQHSRIGII...?GRRG.RNGA?RS$      84
CONSENSUS-B --i-?-----r-----t...-q--a?---S---      93
ISOLATE-C LFPVH FRIGCQHSRIGIF AREKQREWSW
CONSENSUS-D --I-...-----t...RQ--A...--SS--      93
CONSENSUS-O --t-.y-----????-rg--r--SS--      94
CONSENSUS-U --I-...-----T...RQ--A...--SS--      96
CONSENSUS-CPZ ??I-..????-??-----L...PQ--R.S--SN--      54

```

FIGURE 6

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				high-affinity binding site nls	
	\ / 3' sj	exon \ / exon	/ < -	-> /	
DESIGNED SEQ	MAGRSGSTDE ELL RAVRIINILYQSNPYPSSEG	TROTNRNRRRRWRARQ	QIRAI	SERILSTCLGRS	
MUTATED AAs	D K I K	S A R	E	HS N NP P	
ISOLATE-B	MAGRSGSTDE ELL RAVRIINILYQSNPYPSSEG	TROTNRNRRRRWRARQ	QIRAI	SERILSTCLGRS	
CONSENSUS-A	MAGRSG?SDE.eLL.KAIRIIKILYQSNPyPkPkG.SRQARKNRRRRWRARQ	QIDSISerILStCLGRP			66
CONSENSUS-B	-----d-----tv-l--f-----p-s-e-.T-----R-----e-----r-i--w-----y-----s				67
ISOLATE-C	MAGRSGSDSE ELL KAVRIIKILYQSNPYPTPEG	TQARRNRRRRWRARQ	QIH	TLSEILSNFLGRP	
CONSENSUS-F	-----N-?T-----R-?-Y-----E-.T-----R-----?-R??-?-S-----				61
CONSENSUS-O	-----E-...Q?-?Q--Q-----?-?-?-N-----R--A-V-?-A?-?-A-VVHG?				56
CONSENSUS-U	-----DA-----RVV-----P-E-.T--T-----RAI--P-----S				67
CONSENSUS-CPZ	-----?E-?????-?-VK-----?-?-?-?-R-?-?-?-?-V-?-?-?-				41
	Leu-rich effector domain / < - -> /				
DESIGNED SEQ	AEPVPLQLPPLERLHLDCSEDCGTSQTGSGTQOOSQGTETGVGRPQISGESSVILGPGTKN				
MUTATED AAs	N SD	N L AV S			
ISOLATE-B	TEPVPLQLPPLERLHLDCSEDCGTSQTGSGTQOOSQGTETGVGRPQISGESSVILGPGTKN				
CONSENSUS-A	AEPVPLQLPPLERLHLDCSEdcgTSgTQq?qq?etGVGrpQvsVEssavLGSGTKn				120
CONSENSUS-B	-----t-----?-----?-----s--il---p---e-----E\$				115
ISOLATE-C	AEPVPLQLPPLERLNLDCSESDTSGTQOOSQGTTEGVGNP	PREMATURE TRUNCATED			
CONSENSUS-F	E-----?-----?IN?--?-E.Q-A?E.....S--T-G--H-----E\$				105
CONSENSUS-O	Q?NN?VD-----Q-?IRDP-?D?L????TVDPRAEDN\$CL-NLCSCNT???????N\$				95
CONSENSUS-U	-----I---C-----G-----P--T-----S-PI-G---TI-----E\$				123
CONSENSUS-CPZ	PK-GD-E--E-DK-S-Q-V-TTQDV--SNTSQPO-AT-ETVPAGGNYSI--K-A--				97

FIGURE 8

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										env cds ->		
										phos phos		
DESIGNED SEQ	MTPL	EIIAIVAFIVALIIAIVVVTIAYI EYKLLRQR					RIDRL IKRTRERA		EDSGNES			
MUTATED AAs		L	L	VP	K	K	K	E	I			
CONSENSUS-A	mtPL???	eIcAIvGLiVALIILAIVVVTIVgI.eyKkllkqr.....					Kidrl?ikRIRERA.		EDSgNES		57	
CONSENSUS-B	-qs-	q-?--a-v--a-i-----f-?--r-i-R-----					?-----d-----				56	
ISOLATE-C	MVDLLAKVDYRIVIVAFIVALIIAIVVVTIAYI	EYKLLRQR					RIDRL IKRTRERA		EDSGNES			
CONSENSUS-D	-Q--	v-l---A-v-----i-----f--crr-kr-----					w--d-----?				57	
CONSENSUS-F	-S??	LAIS?TA-----I-----?Y--R--R-----					N--YB?--?-----				51	
CONSENSUS-O	-H??	?LL-?I??SAL??INV??-?..P?..LR?Y-?--??QDR?E?E-LE					R.LR--?-IR.D--DY--				42	
CONSENSUS-U	-Q--	T-T-----V--F-A-----S--Y--R-IR--K-----					LD-----				57	
CONSENSUS-CPZ	--??	????L???????W?-CI???I????-??YK???					.....?????-?.??I?????.?????-				14
DESIGNED SEQ	EGDTER LSTM	VDM GNYDLGVDNNL										
MUTATED AAs	R	AL										
CONSENSUS-A	?GDT?E.L?kL....	VEM.GnydlgvdnNL\$										78
CONSENSUS-B	e--qe--sa-????--?	H?apwcdvd--										79
ISOLATE-C	DGDTTE LSTM	VDM GNLRLLDVNDL										
CONSENSUS-D	E--rE--sa-----	HhAPwd?Ddm-										80
CONSENSUS-F	E--AE--A?.....	G--PFIP-DI?---										73
CONSENSUS-O	N?EE-QEVM?.....	?SH-F?NPM.FE??										59
CONSENSUS-U	D---E--ST.....	M--YFYLDND---										81
CONSENSUS-CPZ	-?EE--??-?????????	FANP?..????DE										23

FIGURE 9

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DESIGNED SEQ	TPRPGGGDIKDNWRSELYKYKVKIEPLGVAPTR AKRRVV	EREKRA VG IGAMIFGFLGA	
MUTATED AAs	I NMR E K I K Q L FL		
CONSENSUS-A	?netPrPgGgdardNWrSELYKYKVKIEPLGVAPTR.akkRVV....eREKRA??vg.lGavflgflGa		462
CONSENSUS-B	-t-i-----k-----q-----?i--m-----		480
CONSENSUS-C	-?------e-k-----??-----?i-----		470
CONSENSUS-D	-----r-----?-----I-----m-----		465
CONSENSUS-E	-----NiK-----O-----i-----I-----Mif-----		508
CONSENSUS-F	-?------n-k-----e-----q-----k-----?--l-----		478
CONSENSUS-G	-----k-----R-----G-----?-----		481
CONSENSUS-H	-?V-----??-----?-----?-----?-----		187
CONSENSUS-O	--?--l--?--k--I--T--f--rvK--FS--ki--RP?Igt?t?H-----ML--v--S--		462
CONSENSUS-U	-?------?-----?-----?-----M-----?		435
CONSENSUS-CPZ	-?????-?????-?-?-?-?-?-?-?-S-----??R?????-?-Q--?-?-?-?-?-?-?-?		227

DESIGNED SEQ	AGSTMGAASITLTVOARQLLSGIVQQSNLLRAIEAQHLLQTLVNGIKQLQARVLAVERYLKD QKPLG	
MUTATED AAs	M L N M I OL	
CONSENSUS-A	AGSTMGAASITLTVOARQLLSGIVQQSNLLRAIEAQHLLQTLVNGIKQLQARVLAVERYLKD.QQLLG	531
CONSENSUS-B	-----?-----q-----k-----?	548
CONSENSUS-C	-----n-----m-Q-----t-----i-----k-----	539
CONSENSUS-D	-----?-----N-----Q-----k-----	533
CONSENSUS-E	-----Q-----K-----Kf-----	577
CONSENSUS-F	-----n-----Q-----?	546
CONSENSUS-G	-----V-----Q-----?	549
CONSENSUS-H	-----?-----?-----?-----?	227
CONSENSUS-O	-----ATa-----tht--?K-----D-----Q-----?--R--S-----R--R--L--L--TliQN-----n	529
CONSENSUS-U	-----??--??-----?--??-----N-----Q-----ES-----	496
CONSENSUS-CPZ	-----??--?--?--?--?--?--?--?--?--Q--S--V-----?--?--?--?--?--?	279

DESIGNED SEQ	INGCSGKIICCTTAVPNWSSW	S NKSLEBIWNMTMEWEREISNNTNOIYE ILTESONWQ	
MUTATED AAs	I L N T P D IQ SL K		
CONSENSUS-A	INGCSGKIICCTTAVPNWSSW.....S.Wke??dIWdnMTWlgWdKEIsnYT?iIY?.LiEesngqQ		586
CONSENSUS-B	-----a-----a-----?--l--?--?--me--er--d--l--t-----		603
CONSENSUS-C	-----a-----q-----m--r-----dt--r?--L--d-----		597
CONSENSUS-D	-----h-----r--L--e--?--mE--ER--d--Gl--s-----?		589
CONSENSUS-E	L-----I-----A-----t-----r--fEE--n--iE--eR--Nq--e--ILT-----		636
CONSENSUS-F	L-----qEc--?--ME--e-----SnE--R-----?		603
CONSENSUS-G	-----t-----fnE-----Ie--eR--N--q--n--l-----?		606
CONSENSUS-O	L--K--Y--S--K--?t--?G-----??neS--?L--Q--qq--n--vSS?--e--e--Q?A--?		580
CONSENSUS-U	L-----T-----LVTL--L--ME--R-----QV--G--L--D--K--		555
CONSENSUS-CPZ	L--??--??--?--T--N--?????????--??--?--?--Q?--LV7--?--G?--?--?L??A??--		312

V/ 3'sj

DESIGNED SEQ	DRNEQELLELOKWAELWNWFDITNWLWYIKIPIMIVGGLIGLRIVFAVLISIVNRVRQGYSPISFQTLPLA	
MUTATED AAs	KD A N SK V I I T	
CONSENSUS-A	EKNEqdlLaLDkwanLwnWpdiSnWlWYIriPimIVGGLIGLRivfaVleIInRVRqGYSPISFQtltp?	655
CONSENSUS-B	-----e--e-----?--t-----k-----v-----?l--a-----	671
CONSENSUS-C	-----k-----s--?-----?--t-----k-----i-----V-----n-----	664
CONSENSUS-D	-----e--?-----S-----s--T-----k-----lv-----l--a-----	657
CONSENSUS-E	DR--K--e-----S-----T-----K-----i-----V-----p?Hh-----	705
CONSENSUS-F	-----e-----S-----T-----K-----V-----K-----?--hi--S-----	672
CONSENSUS-G	-----?S--s--s-----k-----v-----?HH-----	674
CONSENSUS-O	---K7--E--E--Si--l--TK-----K--A--I--A--v--VIMI--NlVKNI--Q--L--IP??h-----	647
CONSENSUS-U	--S--K--E--S--G--T-----K-----T--F-----L--T-----	625
CONSENSUS-CPZ	-?-???-?E--?--?S-----T?-----K--?--?--?I?-----????-??R?-----?--?--?--?	355

← tat cds

DESIGNED SEQ	PRG PDRPEGIEEEGG EQDRDSVRLVSGFLALAWDDLRLCLFSYHRLRLDLILI A AR IVELLGHS	
MUTATED AAs	LGR RG G N S N F V T R	

FIGURE 10 (Cont)

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CONSENSUS-O q?E.agT-G-TG-g---a--p-Wtp-Pq---?-LYT---TII-Wt--L-SNLsSg.I.....qk 702
 CONSENSUS-U --G.----G-I-----E-MN--V---N-----E-----I-----L---V.....KG-R... 685
 CONSENSUS-CPZ Q?- .?????E-?-?- .??-?-???-??-???-?-----N-GIW--QS-TSLACN.V.W-#LKT---L 398

<- rev cds

DESIGNED SEQ	SLRGLRRG	WEALKYL WNLLOTWGQELKISAVSILLNATAIAVAEGTDURVIEVAQRAGRAILHI	
MUTATED AAs	K Q	G W G L L N I GW I V W N	
CONSENSUS-A	slkglrlg.....	weglkYL.WNLllyWgrELK?SAInLldtiAiaVAgwtDRvIEigQrigRAIlNI	780
CONSENSUS-B	?...??-.....	a--w---q--sq---n--vm--nat-----Eg-----vv--a?----h	789
CONSENSUS-C	--r--qr-----	a---Gs-vq--l---k--S-----EG--i--??--?--?	787
CONSENSUS-D	.....R-----	a-----q--?q--n--S-----Eg---?--?v--a?--v-h	773
CONSENSUS-E	.....R-----	G-----Q--I--S--naT-----VA-gaW----h	832
CONSENSUS-F	.?R--R-----	A--l-.G--t---Q--N--s--M-T--v--Eg---?--?AL--?	787
CONSENSUS-G	i-----	q--N--?-----N-----vv--aC-----	800
CONSENSUS-O	lI?y-g--LWILGQktIeaCR-c?Av?Q--LQ--qn--T-----?--V--N--gi-lGi---?G---		767
CONSENSUS-U	.....R-----	A-----G--V---Q--N--S--NAT--V--EG---I--V---C-----	741
CONSENSUS-CPZ	I-HS---L-----	R-R-CL-.GGIIQ--K--I--S--AT-----EG---I--AF-VTL-I-R--	460

DESIGNED SEQ	PRRIROGLERALL	
MUTATED AAs	T P	
CONSENSUS-A	PrRIROGLERaLlS	793
CONSENSUS-B	-?-.....	801
CONSENSUS-C	-----F-a--q-	800
CONSENSUS-D	-?-.....	785
CONSENSUS-E	-----	845
CONSENSUS-F	-?-?-?-.....	798
CONSENSUS-G	-----	813
CONSENSUS-O	-----?--	779
CONSENSUS-U	-----P-----	754
CONSENSUS-CPZ	-----	473

FIGURE 10 (Cont)

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DESIGNED SEQ	MGGKNSKSSLVGNPEVRERIRQT	PPAABGVGAUSQD	LDKHGAITSSNTPA	
MUTATED AAs	C P A RA	A A R	Y L A	
ISOLATE-E	MGGKNSKSSIVGNPQVRERIRQT	PPAABGVGAUSQD	LDKHGAVTSSMM	
CONSENSUS-A	MGGKNSKsSiVgNPeVrkRmRqT.....?PAAkGVGAUSQD.....LDKhGAITSSNt??			48
CONSENSUS-B	-----?--?--?--e--ra?????????????--Ep--d-----r-----e-----aa			46
ISOLATE-C	MGGTMSKCSFVGNPAIRERIRRA	APAAEGVGAASRD	LDKYGALTSSNTPA	
CONSENSUS-D	-----AI-E-I-x-?????.....dP--D-----R-----E-----as			50
CONSENSUS-O	--MA??-?KF?-??-?-R?.....???P?-?PC-P---??-RE.....-A?R-G?-H-PQ			38
CONSENSUS-U	--?-----??-E-I-?-???.....P???--?-----?-----?-----?A-			31
\skip6pt				
	SH3-binding | | | SH3-binding			
DESIGNED SEQ	NNADCVMLE AQE E EG VGFPVRPQVPLRPMTYKGAFDLSFFLKEKGGLEGLVYSKQRQEILDWV			
MUTATED AAs	P A E E	A V L	D I Q D	
ISOLATE-E	NNADCVMLE AQE E EG VGFPVRPQVPLRPMTYKGAFDLSFFLKEKGGLEGLVYSKQRQEILDWV			
CONSENSUS-A	tnpsCaWLE?Aqe?.d..e?.VGFPVRPQVPLRPMTYKGAFDLSFFLKEKGGLEGLIys?KQRQEILDWV			110
CONSENSUS-B	--ad-----e??-e?-a?-e-----e---?-q---d-----			108
ISOLATE-C	NNPDCAMLE AQEE E EE VGFPVRPQVPLRPMTYKGAFDLSFFLKEKGGLEGLIYSKQRQEILDWV			
CONSENSUS-D	--ad-----ES--E-----e-----E---W-K-----			115
CONSENSUS-O	N-AAL-P-?SH?.....?-----?--F--F-----?---H--A-----?			93
CONSENSUS-U	N-??-???-??-..E?..E-----?--F--?-----??-----			83
\skip6pt				
	SH3-binding			
DESIGNED SEQ	YHTQGFFPDWNTTPGPGIRY PLTFGNCFKLVFPVDPREVE EINKGENNCLLHPMSQHGMEDEREVL I			
MUTATED AAs	N Y O T	S A E	ICL D K	
ISOLATE-E	YHTQGFFPDWNTTPGPGIRY PLTFGNCFKLVFPVDPREVE EINKGENNCLLHPMSQHGMEDEREVL I			
CONSENSUS-A	YnTQGiFPDQNYTTPGPGIRf.PLTFGNCFKLVpDPaEVR.eat?GENNSLLHPICQHGMdDe?revl m			176
CONSENSUS-B	-h---y-----?--y?-----e-ek-----ne-----msl-----pE-----?			174
ISOLATE-C	YNTQGFFPDWNTTPGPGVRY PLTFGNCFKLVFPVDPSEVE EINEGENNCLLHPASLHGMEDEREVLK			
CONSENSUS-D	-----I-----I-Y-----e-----q-----E--t-c---?-----E-pE-q--k			182
CONSENSUS-O	-?-----?-----?-----L-----S?E-A-RLGNT?-?A?---A-?---?E-?H?-I-?			150
CONSENSUS-U	-H---?-----?-----?-----?-----?-----N-----C-----?S-----?E-----?			138
\skip6pt				
DESIGNED SEQ	WKFDsRLARRHIAREL RPEFY KDC			
MUTATED AAs	H L M H Y			
ISOLATE-E	WKFDsALARRHIAREL RPEFY KDC			
CONSENSUS-A	WkFDsRLAlkhRa?ElHPeFY.KDC\$			199
CONSENSUS-B	-x-----fh-m-x-----y-----?TSMCLOGTFRWNGISREARLGGTGENRALRCCI			230
ISOLATE-C	WKFDsHLARRHIAREL RPEFY KDC			
CONSENSUS-D	-R-N-----fE-K-R-m-----			206
CONSENSUS-O	-?-RS-G?Y-?-?-?-LF?-?			166
CONSENSUS-U	-----S-??-?-R-?-?-?-?			157

FIGURE 11

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GAG OVERLAPPING SEGMENTS

M G A R A S V L S G G K L D A W E K I R L R P G G K K Y ^{Segment 1}
 atg ggc gcc agc rtc ctc agc rtc agm ggc ggc rag ctg gac gcc tgg gaa aag att agg ctc agg cct ggc gga aag aaa aag tat arg
 W E K I R L R P G G K K K Y K M K H L V W A S R E L E R F A ^{Segment 2}
 tgg gag aaa atc aga ctg aga ccc gga ggc aaa aag aaa tac ara mtg aaa cac mtt gtg tgg gcc tcc agg gaa ctg gaa agg ttt gcc
 M K H L V W A S R E L E R F A L N P G L L E T A E G C Q Q I ^{Segment 3}
 L I mtg aag cat mtc gtc tgg gct agc aga gag ctc gag aga ttc gct ctg aat ccc rgc ctg ctc gag aca kcc gaa ggc tgt mag caa att
 L N P G L L E T A E G C Q Q I L E Q L Q S A L K T G S E E L ^{Segment 4}
 ctc aac cct tgc ctc ctg gaa acc kct gag gga tgt maa cag atc ctg gra cag ctc cag ycc gcc ctc mag aca ggc wcc gaa gag ctc
 L E Q L Q S A L K T G S E E L K S L Y N T I A T L W C V H Q ^{Segment 5}
 ctc gtg caa ctg caa yct gct ctg maa acc gga wca gag gaa ctg arg tcc ctg twt aac aca rtc gct acc ctc tgg tgt gtc cat cag
 K S L Y N T I A T L W C V H Q R I E V K D T K E A L C K I E ^{Segment 6}
 ara arg ctc tvc aat acc rtc gcc aca ctg tgg tgc ctc cac caa agg att gaa gtc arg gac aca aag gaa gcc ctc gac aaa atc gaa

FIGURE 12

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R I E V K D T K E A L D K I E E E Q K K S Q Q K T Q Q A A A Segment 7
 D R V N K
 aga atc gaw gtg ara gat acc aaa gag gct ctg gat aag att gag gag gwg caa aas aaa agc mag caa aag aca caa cag gct gcc gct

 E E Q K K S Q Q K T Q Q A A D T G S S S K V S Q N Y P I V Segment 8
 V N K Q
 gaa gwa cag aaw aag tcc maa cag aaa acc cag caa gcc gcc gcc gat aca ggc arc tcc agc mag gtc agc caa aac tat ccc att gtg
 D T G S S S K V S Q N Y P I V Q N A Q G Q M V H Q P L S P R Segment 9
 N Q L A I
 gac acc gga art agc tcc maa gtg tcc cag aat tac cct atc gtc cag aat ayc caa ggc caa atg gtc cac caa gcc mtc tcc ccc aga

 Q N A Q G Q M V H Q P L S P R T L N A W V K V I E E K G F N Segment 10
 L A I V A S
 caa aac ayc cag gga cag atg gtg cat cag sct.mtt agc cct agg acc ctc aac gct tgg gtc aag gtc rtc gaa gag aaa gac ttt arc

 T L N A W V K V I E E K G F N P E V I P M F S A L S E G A T Segment 11
 V A S T
 aca ctg aat gcc tgg gtg aaa gtg rtt gag gaa aag gaa ttc art ccc gaa gtg att ccc atg ttt wcc gct ctg tcc gag gga gcc aca

FIGURE 12 (Cont)

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I P V G D I Y K R W I I L G L N K I V R M Y Q P V S I L D I Segment 18
 V E
 rtt ccc gtg ggc gaw atc tat aag aga tgg atc att ctg gga ctc aac aaa atc gtg aga atg tat yma ccc gtc agc att ctg gat atc
 S
 N K I V R M Y Q P V S I L D I R Q G P K E P F R D Y V D R F Segment 19
 S K
 aat aag att gtc agg atg tac yma cct ctc tcc atc ctc gac att arg caa ggc cct aag gaa ccc ttt agg gat tac gtc gac aga ttc
 R Q G P K E P F R D Y V D R F Y K T L R A E Q A T Q E V K N Segment 20
 K F S D
 ara cag gga ccc aaa gag cct ttc aga gac tat gtg gat agg ttt tvc aaa acc ctc agg gct gag caa gcc wca cag gaw gtg aaa aac
 Y K T L R A E Q A T Q E V K N W M T E T L L V Q N A N P D C Segment 21
 F S D
 tvt aag aca ctg aga gcc gaa cag gct wcc caa gas gtc aag aat tgg atg acc gaa aca ctg ctc gtg caa aac gct aac cct gac tgt
 W M T E T L L V Q N A N P D C K S I L K A L G T G A T L E E Segment 22
 D T R P S
 tgg atg aca gaw acc ctc ctg gtc cag aat gcc aat ccc gat tgc aag wcc atc ctc arg gct ctg gga mcc gga gcc wca ctg gaa gag
 K S I L K A L G T G A T L E E M M T A C Q G V G G P S H K A Segment 23
 T R P S G
 aaa wca att ctg ara gcc ctc ggc mca ggc gct wcc ctc gag gaa atg atg aca gcc tgt cag gga gtg gga ggc cct xgc cat aag gct

FIGURE 12 (Cont)

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M M T A C Q G V G G P S H K A R V L A E A M S Q A T H A N I Segment 24
G
atg atg acc gct tgc caa ggc gtc ggc gga ccc rgt cac aaa gcc agg gtc ctg gca gag gct atg tcc cag gyg amc mac gct aac att
R V L A E A M S Q A T H A N I M M Q R G N F K G Q K R I I K Segment 25
V N N
aga gtg ctc gcc gaa gcc atg agc caa gyc amc mat gcc aat atc atg atg cag aga ggc aat ttc ara ggc cna aag aga atc rtc aaa
M M Q R G N F K G Q K R I I K C F N C G K E G H L A F N C R Segment 26
R P V
atg atg caa agg gga aac ttt arg gga cmg aaa agg att rtc aag tgc ttt aac tgt gga aag gaa ggc cat mtc gct arg aat tgc aga
C F N C G K E G H L A R N C R A P R K K G C W K C G K E G H Segment 27
I K R
tgt ttc aat tgc ggc aaa gag gga cac mtt gcc ara aac tgt agg gcc cct aga aag aaa ggc tgt tgg aaa tgc gga arg gaa ggc cat
A P R K K G C W K C G K E G H Q M K D C T E R Q A N F L G K Segment 28
R
gct ccc agg aaa aag gga tgc tgg aag .tgt ggc ara gag gga cac cag atg aag gat tgc aca gag aga cag gct aac ttt ctg gga aag
Q M K D C T E R Q A N F L G K I W P S N K G R P G N F P Q S Segment 29
H L S
caa atg aaa gac tgt acc gaa agg caa gcc aat ttc ctc ggc aaa atc tgg ccc tcc mrc aaa ggc aga ccc gga aac ttt ctc caa agc

FIGURE 12 (Cont)

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I W P S N K G R P G N F P Q S K P E P T A P P A E N F G F G Segment 30
H L R S R
S
att tgg cct agc mrc aag gga agg cct ggc aat ttc cyg cag tcc arg cct gag cct acc gct ccc cct gcc gaa arc ttt tga ttc ggc
K P E P T A P P A E N F G F G E E T T P S P K Q E Q K D K E Segment 31
R S R Q P
ara ccc gaa ccc aca gcc cct ccc gct gag art ttc rgg ttc gga gag gaa acc aca ccc tcc cma aag caa gag cma aag gat aag gag
E E T T P S P K Q E Q K D K E H Y P P S A S L K S L F G N D Segment 32
Q P L L
gaa gag aca acc cct agc cmg aaa cag gaa cmg aaa gac aaa gaa cvc tac ccc cct tya gcc agc etc aag tcc ctg ttt ggc aat gac
(H) Y P P S A S L K S L F G N D P L S Q Segment 33
L S
cvc tat cct ccc tya gct tcc ctg aaa agc etc ttc gga aac gat ccc tya tcc caa

FIGURE 12 (Cont)

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POL OVERLAPPING SEGMENTS

F F R E N L A F Q Q G K A R E F S S E Q T G A N S S A S R K Segment 1
 ttc ttt agg gaa amc ctg gct ttc cmg caa ggc raa gcc aga gag ttt ycc agc gaa cag aca rga gcc aat agc ycc tcc tcc agg aaa
 P E P T
 F S S E Q T G A N S S A S R K L G D G G A E R Q G T S S S Segment 2
 P R P T D
 ttc yct tcc gag caa aca rgg gct aac tcc yct rca agc aga aag ctg gga gac gga ggc gga gcc gas aga cag gga aca agc tcc agc
 L G D G G A E R Q G T S S S F S F P Q I T L W Q R P L V T Segment 3
 D L N
 ctc ggc gat ggc gga ggc gct gaw agg caa ggc acc tcc agc tcc ytc arc ttt ccc caa atc aca ctg tgg caa agg cct ctg gtc acc
 F S F P Q I T L W Q R P L V T I K I G G Q L K E A L L D T G Segment 4
 L N V I
 ytt art ttc cct cag att acc ctc tgg cag aga ccc ctc ctg aca rtc aaa atc ggc gga cag ctc awa gag gct ctg ctc gac aca ggc
 I K I G G Q L K E A L L D T G A D D T V L E D I N L P G K W Segment 5
 V I E M R
 rtt aag att gga ggc caa ctg awa gaa gcc ctc ctg gat aca gga gcc gat gac acc gtc ctg gaa gaw ata aat ctg cct ggc arg tgg
 A D D T V L E D I N L P G K W K P K M I G G I G G F I K V R Segment 6
 E M R
 gct gac gat aca gtg ctc gag gas ata aac ctc ccc gga ara tgg aag cct aag atg att ggc gga atc ggc gga ttc att aag gtg aga

FIGURE 12 (Cont)

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K P K M I G G I G G F I K V R Q Y D Q I L I E I C G K K A I Segment 7
 I H
 aaa ccc aaa atg atc gga ggc ttt atc aaa gtc agg cag tat gac caa atc mtt atc gaa atc tgt gga mas aag gct atc
 Q Y D Q I L I E I C G K K A I G T V L V G P T P V N I I G R Segment 8
 I H
 caa tac gat cag att mtt att gag att tgc ggc mas aaa gcc att ggc aca gtc ctc gtc gga cct acc cct gtc aat atc att ggc aga
 G T V L V G P T P V N I I G R N M L T Q I G C T L N F P I S Segment 9
 L R
 gga acc gtc ctc gtc ggc ccc aca ccc gtc aac att atc gga agg aac mtg ctg aca cag mtt ggc ygc acc ctc aac ttt ccc att agc
 N M L T Q I G C T L N F P I S P I D T V P V K L K P G M D G Segment 10
 L R E
 aat mtg ctc acc caa mtc gga ygc aca ctg aat ttc cct atc tcc ccc att gas aca gtc cct gtc aaa ctg aaa ccc gga atg gat ggc
 P I D T V P V K L K P G M D G P K V K Q W P L T E E K I K A Segment 11
 E
 cct atc gaw acc gtc ccc gtc aag cct ggc atg gac gga ccc aaa gtc aaa cag tgg ccc ctc acc gaa gay aaa atc aaa gcc
 P K V K Q W P L T E E K I K A L T E I C K E M E E G K I S Segment 12
 A T K Q
 cct aag gtc aag caa tgg cct ctg aca gag gaa aag att aag gct ctg aca gmg att tgc ana gag atg gag vaa gag gga aag att agc

FIGURE 12 (Cont)

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L T E I C K E E E G K I S K I G P E N P Y N T P V F A I Segment 13
 A T K Q
 ctc acc gmg atc tgt ama gaa atg gaa vaa gaa ggc aaa atc tcc arg att ggc cct gag aat ccc tat aac aca ccc rtc ttt gcc att
 K I G P E N P Y N T P V F A I K K K D S T K W R K L V D F R Segment 14
 R I
 arg atc gga ccc gaa aac cct tac aat acc cct rtc ttc gct atc aag aaa aag gac tcc acc aaa tgg aga aag ctc gtg gat ttc aga
 K K K D S T K W R K L V D F R E L N K R T Q D F W E V Q L G Segment 15
 aaa aag aaa gat agc aca aag tgg agg aaa ctg gtc gac ttt agg gag ctc aac aaa agg aca cag gat ttc tgg gag gtc cag ctc ggc
 E L N K R T Q D F W E V Q L G I P H P A G L K K K S V T V Segment 16
 gaa ctg aat aag aga acc caa gac ttt tgg gaa gtg caa ctg gga atc cct cac cct gct gga ctg aaa aag aaa aag tcc gtg aca gtg
 I P H P A G L K K K S V T V L D V G D A Y F S V P L D E S Segment 17
 K D G
 att ccc cat ccc gcc ctc aag aaa aag aaa agc gtc acc gtc ctg gat gtg gga gac gct tac ttt agc gtc ccc ttc gac raa rrc

FIGURE 12 (Cont)

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L D V G D A Y F S V P L D E S F R K Y T A F T I P S I N N E
 Segment 18
 T
 ctc gac gtc ggc gat gcc tat ttc tcc gtg cct ctg gat xaa xrc ttc aga aag tat acc gct ttc aca atc cct agc aya aac aat gag
 F R K Y T A F T I P S I N N E T P G I R Y Q Y N V L P Q G W
 Segment 19
 T
 ttt agg aaa tac aca gcc ttt acc att ccc tcc ayc aat aac gaa acc cct ggc att agg tat cag tat aac gtc ctg cct cag gga tgg
 T P G I R Y Q Y N V L P Q G W K G S P A I F Q S S M T K I L
 Segment 20
 P
 aca ccc gga atc aga tac caa tac aat gtg ctc ccc caa ggc tgg aag gga tcc ccc acc att ttc caa agc tcc atg mcc maa atc ctc
 K G S P A I F Q S S M T K I L E P F R I K N P E M V I Y Q Y
 Segment 21
 P
 aaa ggc agc cct act atc ttt cag tcc agc atg mca mag att ctg gag cct ttt agg awa maa aac cct gaa atg gtc atc tat cag tat
 E P F R I K N P E M V I Y Q Y M D D L Y V G S D L E I G Q H
 Segment 22
 K Q D
 gaa ccc ttc aga awa mag aat ccc gaw atg gtg att tac caa tac atg gac gat ctg tat gtg gga agc gat ctg gaa atc gga cag cat

FIGURE 12 (Cont)

Segment 23
M D D L Y V G S D L E I G Q H R T K I E E L R A H L L R W G
A E K
atg gat gac ctc tac gtc ggc tcc gac ctc gag att ggc caa cac agg rcc aaa atc gaa gag ctc agg sma cac ctc ctg ara tgg gga
Segment 24
R T K I E E L R A H L L R W G F T T P D K K H Q K E P P F L
A E K
aga rca aag att gag gaa ctg aga smg cat ctg ctc ara tgg ggc ttc aca acc cct gac aaa aag cat cag aaa gag cct ccc ttt ctg
Segment 25
F T T P D K K H Q K E P P F L W M G Y E L H P D R W T V Q P
ttt acc aca ccc gat aag aaa cac caa aag gaa ccc cct ttc ctc tgg atg gga tac gaa ctg cat ccc gat agg tgg acc gtc cag cct
Segment 26
W M G Y E L H P D R W T V Q P I E L P E K D S W T V N D I Q
V E
tgg atg ggc tat gag ctc cac cct gac aga tgg aca gtg caa ccc atc swg ctc ccc gaa aag gaa tcc tgg aca gtg aat gac att cag
Segment 27
I E L P E K D S W T V N D I Q K L V G K L N W A S Q I Y A G
V E P
att swg ctg cct gag aaa gaw agc tgg acc gtc aac gat atc caa aag ctc gtg gga aag ctc aac tgg gcc tcc cag att tac acc gga

FIGURE 12 (Cont)

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K L V G K L N W A S Q I Y A G I K V K Q L C K L L R G T K A Segment 28
 aaa ctg gtc ggc aaa ctg aat tgg gct agc caa atc tat act ggc atc aaa gtg arg caa ctg tgt aag ctg aga ggc rcc aaa gcc
 I K V K Q L C K L L R G T K A L T D I V P L T E E A E L E L Segment 29
 att aag gtc ara cag ctg tgc aaa ctg ctc agg gga rca aag gct ctg aca gaa att gtg mca ctg aca gag gaa gcc gaa ctg gaa ctg
 L T D I V P L T E E A E L E L E E N R E I L R E P V H G V Y Segment 30
 ctc acc gaw atc gtc mca ctc acc gaa gag gct gag ctc gag ctc gmg gaa aac aga gag att ctg arg gaa ccc gtc cac gga gtg tat
 E E N R E I L R E P V H G V Y Y D P S K D L V A E V Q K Q G Segment 31
 gmg gag aat agg gaa atc ctc ara gag cct gtg cat ggc gtc tac gat ccc tcc aag gat ctg rtc gct gaa rtc caa aag caa ggc
 Y D P S K D L V A E V Q K Q G Q D Q W T Y Q I Y Q E P F K N Segment 32
 tat gac cct agc aaa gac ctc rtt gcc gag rtt cag aaa cag gga cag grt cag tgg aca tvt cag att tvc caa gag cct ttc aaa aac
 Q D Q W T Y Q I Y Q E P F K N L K T G K Y S R K R S A H T N Segment 33
 caa gtc caa tgg acc tvc caa atc tvt cag gaa ccc ttt aag aat ctg aaa acc gga aag tat kcc aga awg aga tgc gct cac aca aac

FIGURE 12 (Cont)

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L K T G K Y S R K R S A H T N D V R Q L T E V V Q K I A T E Segment 34
 A M G K A A V
 ctc aag acc ggc aaa tac kct agg awg agg rgt gcc cat acc aat gac ctc arg caa ctg aca gmw gyt gtg caa aag rtt gcc aca gag

D V R Q L T E V V Q K I A T E S I V I W G K T P K F R L P I Segment 35
 K A A V K
 gat ctg ara cag ctc acc gma gyc gtc cag aaa rtc gct acc gaa agc att gtg att tgg gga aag aca ccc aaa ttc ara ctg cct atc

S I V I W G K T P K F R L P I Q R E T W M E Y W Q A Segment 36
 K K A T D
 tcc atc gtc atc tgg ggc aaa acc cct aag ttt arg ctc ccc att cag ara gag aca tgg gaa rcc tgg tgg ayg gas tat tgg caa gcc

Q R E T W E T W M E Y W Q A T W I P E W E F V N T P P L V Segment 37
 K A T D
 caa arg gaa acc tgg gag rct tgg tgg ayg gam tac tgg cag gct acc tgg atc cct gag tgg gag ttt gtg aat acc cct ccc ctc gtg

T W I P E W E F V N T P P L V K L W Y Q L E K D P I V G A E Segment 38
 A A V E A V
 aca tgg att ccc gaa tgg gaa ttc gtc aac aca ccc cct ctg gtc aag ctc tgg tat cag ctc gag aaa gas cct atc gyt ggc gyt gag

K L W Y Q L E K D P I V G A E T F Y V D G A A S R E T K L G Segment 39
 E A V N
 aaa ctg tgg tac caa ctg gaa aag gam ccc att gyc gga gyc gaa acc ttt tac gtc gac gga gcc gct arc aga gag aca aag ctc ggc

FIGURE 12 (Cont)

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T F Y V D G A A S R E T K L G K A G Y V T D R G R Q K V I S Segment 40
 N I V
 aca ttc tat gtg gat ggc gct gcc art agg gaa acc aaa ctg gga aag gct ggc tat gtg aca gac aga ggc aga cag aaa rtc rtt agc

 K A G Y V T D R G R Q K V I S L T E T T N Q K T E L H A I H Segment 41
 I V D Q
 aaa gcc gga tac gtc acc gat agg gga agg caa aag rtt rtc tcc ctg aca gaa aca acc aat cag aaa acc gaa ctg caw gcc att cam

 L T E T T N Q K T E L H A I H L A L Q D S G S E V N I V T D Segment 42
 D Q L
 ctc acc gam acc aca aac caa aag aca gag ctc cam gct atc caw ctg gct ctg caa gac tcc ggc tya gag gtc aac att gtg aca gac

 L A L Q D S G S E V N I V T D S Q Y A L G I I Q A Q P D R S Segment 43
 L K
 ctc gcc ctc cag gat agc gga tyg gaa gtg aat atc gtc acc gat agc caa tac gct ctg gga atc att cwg gct cag cct gac ara agc

 S Q Y A L G I I Q A Q P D R S E S E V V S Q I I E E L I K K Segment 44
 L K N Q
 tcc cag tat gcc ctc gcc att atc cwa gcc caa ccc gat arg tcc gag tcc gag stc gtg art cag att atc gaa vag ctc atc aaa aag

 E S E V V S Q I I E E L I K K E K V Y L S W V P A H K G I G Segment 45
 L N K S R A Q
 gag tcc gag stc gtg art cag att atc gaa vag ctc atc aaa aag gaa arg gtc tac ctc kcc tgg gtg cct gcc cac aag gga atc gga

FIGURE 12 (Cont)

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E K V Y L S W V P A H K G I G G N E Q V D K L V I S G I R K Segment 46
 R A gag ara gtg tat ctg kct tgg gtc ecc gct cat aaa ggc att ggc gga aac gaa cag gtc gac aaa ctg gtc akc kct ggc att agg aaa
 G N E Q V D K L V I S G I R K V L F L D G I N K A Q E E H E Segment 47
 S A ggc aat gag caa gtg gat aag ctg gtc gat kcc gga atc aga aag gtg ctg ctg gac gga atc rat aag gct cag gaa gag cac gaa
 D V L F L D G I N K A Q E E H E R Y H S N W R T M A S D F N L Segment 48
 K gtc ctg ttt ctg gat ggc att rac aaa gcc caa gag gaa cat gag arg tat cac tcc aac tgg agg aca atg gct arc gam ttc aat ctg
 (R) Y H S N W R T M A S D F N L P P I V A K E I V A N C D K C Segment 49
 K N E P S C ara tac cat agc aat tgg aga acc atg gcc art gaa ttt aac ctg ecc cct atc gtc act aag gaa atc gtc gcc vrt tgc gat aag tgc
 P P I V A K E I V A N C D K C Q L K G E A M H G Q V D C S P Segment 50
 P S I C cct ccc att gtg acc aaa gag att gtg gct wrc tgc gac aaa tgc cag ctg aag gga gag gct atk cac gga cag gtc rac tgc agc cct

FIGURE 12 (Cont)

Segment 51
Q L K G E A M H G Q V D C S P G I W Q L D C T H L E G K V I
I N
caa ctg aaa ggc gaa gcc ats cat ggc caa gtg rat tgc tcc ccc ggc att tgg caa ctg gat tgc aca cac ctg gag gga aag rtt atc
Segment 52
G I W Q L D C T H L E G K V I L V A V H V A S G Y I E A E V
I
gga atc tgg cag ctg gac tgt acc cat ctg gaa ggc aaa ttc att ctg gtc gcc ctg cac gtc gcc tcc ggc tac att gag gct gag gtc
Segment 53
L V A V H V A S G Y I E A E V I P A E T G Q E T A Y F L L K
I
ctc gtg gct gtg cat gtg gct agc gga tat atc gaa gcc gaa gta atc cct gcc gaa acc gga cag gaa acc gct tac ttt mtc ctc aag
Segment 54
I P A E T G Q E T A Y F L L K L A G R W P V K V I H T D N G
I R T
att ccc gct gag aca ggc caa gag aca gcc tat ttc mtt ctg aaa ctg gct ggc aga tgg cct gtg ara ryc att cac aca gac aat ggc
Segment 55
L A G R W P V K V I H T D N G S N F T S A A V K A A C W W A
R T T T
ctc gcc gga agg tgg ccc gtc arg rya atc cat acc gat aac gga agc aat ttc aca agc rct rcc gtc aag gct gcc tgc tgg tgg gct
Segment 56
S N F T S A A V K A A C W A N I K Q E F G I P Y N P Q S Q
T T G Q
ccc aac ttt acc tcc rcc rct gtg aaa gcc gct tgt tgg tgg gcc rrt atc maa cag gaa ttc gga atc cct tac aat ccc caa agc caa

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N I K Q E F G I P Y N P Q S Q G V V E S M N K E L K K I I G Segment 57
 G Q
 rrc att mag caa gag ttt ggc att ccc tat aac cct cag tcc cag ggc gtc gtc gaa agc atg aac aaa gag ctc aag aaa atc att ggc

 G V V E S M N K E L K K I I G Q V R E Q A E H L K T A V Q M Segment 58
 D
 gga gtc gtc gag tcc atg aat aag gaa ctg aaa aag att atc gga cag gtc agg gam cag gct gag cat ctg aaa acc gct gtc caa atg

 Q V R E Q A E H L K K T A V Q M A V F I H N F K R K G I G G Segment 59
 D R
 caa gtc aga gaa caa gcc gaa cac ctc aag aca gcc gtc cag atg gcc gtc ttc att cac aat ttc aaa agg ara ggc gga atc gga ggc

 A V F I H N F K R K G G I G G Y S A G E R I I D I I A T D I Segment 60
 V S
 gct gtc ttt atc cat aac ttt aag aga arg gga ggc att ggc gga tac tcc gcc gga gag aga atc rtt gac att atc gct aac gat atc

 Y S A G E R I I D I I A T D I Q T K E L Q K Q I T K I Q N F Segment 61
 V S N L
 tat agc gct ggc gaa agg att rtc gat atc att gcc wcc gac att cag tat aag gaa ctg caa aas caa atc mya aag att cag aat ttc

 Q T K E L Q K Q I T K I Q N F R V Y Y R D S R D P I W K G P Segment 62
 N L L
 caa tac aaa gag ctc aam cag att myc aaa atc caa aac ttt agg gtc tac tat agg gat agc aga gac cct mtc tgg aag gga ccc

FIGURE 12 (Cont)

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R V Y Y R D S R D P I W K G P A K L L W K G E G A V V I Q D Segment 63
 L
 aga gtg tat tac aga gac tcc agg gat ccc mtt tgg aaa ggc cct gcc aaa ctg ctc tgg aaa ggc gaa ggc gct gtg gtc atc caa gac
 A K L L W K G E G A V V I Q D N S D I K V V P R R K A K I I Segment 64
 gct aag ctc ctg tgg aag gga gag gga gcc gtc gtg att cag gat aac tcc gac att aag gtc gtc cct agg aga aag gct aag att atc
 N S D I K V V P R R K A K I I R D Y G K Q M A G D D C V A G Segment 65
 A
 aat agc gat atc aaa gtg gtc ccc aga agg aaa gcc aaa atc att agg gat tac gga aag caa atg gct ggc gmt gac tgt gtg gct rgc
 R D Y G K Q M A G D D C V A G R Q D E D Segment 66
 A S
 agg gat tac gga aag caa atg gct ggc gmt gac tgt gtg gct rgc agg caa gac gaa gac

FIGURE 12 (Cont)

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VIF OVERLAPPING SEGMENTS

M E N R W Q V M I V W Q V D R M R I R T W N S L V K H H M Y	Segment 1
atg gaa aac aga tgg caa gtg atc gtc tgg caa gtg gat agg atg arg att agg aca tgg aaw agc ctc gtg aaa cac cat atg yat	H
M R I R T W N S L V K H H M Y I S K K A K G W F Y R H H Y E	Segment 2
atg ara atc aga tac tgg aas acc ctg gtc aag cat cac atg yac atc tcc aag aaa gcc aaw ggc tgg ttc tat agg cat cac twt gaa	F D
I S K K A K G W F Y R H H Y E S Q H P K V S S E V H I P L G	Segment 3
att agc aaa aag gct aas gga tgg ttt tac aga cac cat twc gav agc cra cac cct aag gtc agc tcc gag gtc cac att ccc ctc ggc	
S Q H P K V S S E V H I P L G E A R L V I R T Y W G L Q T G	Segment 4
tcc crg cat ccc aaa gtg tcc agc gaa gtg cat atc cct ctg gga gaa gct agg ctc rtc att arg aca tac tgg ggc ctc cas aca ggc	H
E A R L V I R T Y W G L Q T G E K D W Q L G H G V S I E W R	Segment 5
gaw gcc aga ctg rtt atc ara acc tat tgg gga ctg caw acc gga gag ara gac tgg cas ctc ggc caw ggc gtc agc att gag tgg agg	Q

FIGURE 12 (Cont)

Segment 6
 E K D W Q L G H G V S I E W R Q K R Y S T Q V D P D L A D Q
 R H Q L S K H
 gaa arg gat tgg caw ctg gga caa gga gtg tcc atc gaa tgg aga mwg aaa ags tat agc aca cag gtc gac cct gtc ctc gcc gat caa
 Segment 7
 Q K R Y S T Q V D P D L A D Q L I H L Q Y F D C F S D S T I
 L S H G H Y A
 mwg aag agm tac tcc acc caa gtg gat ccc grt ctg gct gac caw ctg att cac ctg yas tat ttc gat tgc ttt kcc gat agc rca atc
 Segment 8
 L I H L Q Y F D C F S D S T I R R A I L G Q I V R R R C E Y
 H Y A H R S
 ctc atc cat ctg yaw tac ttt gac tgt ttc kct gac tcc rcc att agg aga gcc att ctg gga caa aka gtg agm agg aga tgc gaa tac
 Segment 9
 R R A I L G Q I V R R R C E Y P S G H N K V G S L Q Y L A L
 H R S Q A
 aga agg gct atc ctc gcc caw aka gtc ags aga agg tgt gag tat cmg kcc gga cac aat aag gtc ggc tcc ctg caa tac ctc gcc ctc
 Segment 10
 P S G H N K V G S L Q Y L A L K A L I T P K K I R P P L P S
 Q A T K K
 cma kct ggc cat aac aaa gtg gga agc ctc cag tat ctg gct ctg amg gct ctg att amg cct aag aaa atc ara' ccc cct ctg cct agc

FIGURE 12 (Cont)

Segment 11

K A L I T P K K I R P P L P S V K K L T E D R W N K P Q K I
T K K
ama gcc ctc atc ama ccc aaa aag att arg cct ccc ctc ccc tcc gtg aaa aag ctc acc gaa gac ara tgg aat rag cct caa aag aya

Segment 12

V K K L T E D R W N K P Q K I K G H R E N H T M N G H
K E T R G
gtc aag aaa ctg aca gag gat arg tgg aac raa ccc cag aaa ayc aag gga crc aga gra ant cac aca atg aat ggc cat

FIGURE 12 (Cont)

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I R T L Q Q L M F I H F R I G C Q H S R I G I L R Q R R A R Segment 5
 I L V
 att agg ayc ctg caa cag ctc mtg ttc xtt cac ttt agg att ggc tgc crg cac tcc agg att ggc att myc aga cag aga agg gac aga
 C Q H S R I G I L R Q R R A R N G A S R S Segment 6
 R G S
 tgt cra cat agc aga atc gga atc myc agg caa agg aga gat agg aac gga kcc tcc agg tcc

FIGURE 12 (Cont)

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TAT OVERLAPPING SEGMENTS

Segment 1	M	E	L	V	D	P	N	L	E	P	W	N	H	P	G	S	Q	P	T	A	C	S	K	C	Y	C	K	K	C
	D	P					K				K								K		T								
																							</						

FIGURE 12 (Cont)

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Segment 6

Q T R G [Ⓢ] N P T D P K E S K K E V A S K T E T D P C D
P D G E K E A F
caa mcc aga ggc grt aac cct acc grt ccc raa gag tcc ang aaa rag gtc gmg tcc asg rca gag aca gac cct tkt gac

* different

FIGURE 12 (Cont)

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P P L E R L H L D C S E D C G T S G T Q Q S Q G T E T G V G Segment 6
 N S D
 cct ccc ctc gag aga ctg mac ctg gat tgc tcc gag gat wgc grt acc tcc ggc aca cag caa agc caa ggc aca gag aca gga gtc gga

 T S G T Q Q S Q G T E T G V G R P Q I S G E S S V I L G P G Segment 7
 N L A V S
 S
 aca agc gga acc caa cag tcc cag gga acc gaa acc ggc gtc ggc mrc cct cag att tyg gga gag tcc agc gyt rtc ctc ggc ycc gga

 (R) P Q I S G E S S V I L G P G T K N Segment 8
 (N) (L) A V S
 S
 mrc ccc caa atc tya ggc gaa agc tcc gyc rtt ctg gga yct ggc acc aaa aac

FIGURE 12 (Cont)

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VPU OVERLAPPING SEGMENTS

M T P L E I I A I V A F I V A L I I A I V V W T I A Y I E Y Segment 1
 atg aca ycc ctc aag ara atc gct atc gtc gcc ytt atc gtc gcc ctc atc mta gcc att gtc gtc tgg aca atc gyc twc att gag tat
 L I I A I V V T I A Y I E Y R K L L R Q R R I D R L I K R Segment 2
 ctg att mtc gct atc gtc tgg acc att gvg tvt atc gaa tac arg aaa ctg ctc arg caa agg ara atc gat agg ctc atc raa agg
 R K L L R Q R R I D R L I K R T R E R A E D S G N E S E G D Segment 3
 ara aag ctc ctg ara cag aga arg att gac aga ctg att rag aga ayc aga gag aga gcc gaa gac tcc ggc aat gag tcc gag gga gac
 T R E R A E D S G N E S E G D T E E L S T M V D M G N Y D L Segment 4
 I aya agg gaa agg gct gag gat agc gga aac gaa agc gaa ggc gat asa gaa gag ctc agc rca wtg gtc gac atg ggc aat tac gat ctg
 T E E L S T M V D M G N Y D L G V D N N L Segment 5
 R aaa gag gaa ctg tcc rcc wtg gtg gat atg gga aac tat gac ctc ggc gtc gac aat aac ctc

FIGURE 12 (Cont)

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ENV OVERLAPPING SEGMENTS

M R V K E T Q M N W P N L W K W G T L I L G L V I I C S A S Segment 1
 atg aga gtc aaa gag aca cag atg aac tgg ccc aat ctg tgg arg tgg ggc aca mtg att ctg gga mtg gtc ats att tgc tcc gcc tcc
 W G T L I L G L V I I C S A S D N L W V T V Y G V P V W R Segment 2
 tgg gga acc wtg atc ctc ggc wtg atk atc tgc agc gct agc gaa aat ctg tgg gtg aca gtg tat tac gga gtg cct gtg tgg agg
 D N L W V T V Y G V P V W R D A D T T L F C A S D A K A H Segment 3
 E gam aac ctc tgg gtc acc gtc tac tat ggc gtc ccc gtc tgg aga gaa gct xmc aca acc ctc ttc tgt gcc tcc gac gct aag gct yac
 D A D T T L F C A S D A K A H E T E V H N V W A T H A C V P Segment 4
 E gam gcc xmt acc aca ctg ttt tgc gct agc gat gcc aaa gcc yat gaa aca gag gtc cac aat gtg tgg gcc aca cac gct tgc gtc ccc
 E T E V H N V W A T H A C V P T D P N P Q E I H L E N V T E Segment 5
 D gam acc gaa gtg cat aac gtc tgg gct acc cat gcc tgt gtg cct acc gat ccc aat ccc caa gag rtt svc ctc gag aat gtg aca gag
 T D P N P Q E I H L E N V T E N F N M W K N N M V E Q M Q E Segment 6
 V V aca gac cct aac cct cag gaa rtc avt ctg gaa aac gtc acc gaa aac ttt aac atg tgg aaa aac rat atg gtc gaa caa atg caw gag

FIGURE 12 (Cont)

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N F N M W K N N M V E Q M Q E D V I S L W D Q S L K P C V K Segment 7
 aat ttc aat atg tgg aag aat rac atg gtg gam cag atg cam gaa gac rtt atc tcc ctg tgg gac caa agc ctc aag cct tgc gtc aag
 D H I
 D V I S L W D Q S L K P C V K L T P L C V T L N C T N A N L Segment 8
 I
 gat rtc att agc ctc tgg gat cag tcc ctg aaa ccc tgt gtg aaa ctg aca ccc ctc tgc gtc acc ctc aac tgt acc aat gcc aat ctg
 L T P L C V T L N C T N A N L I N V N Segment 9
 ctc acc cct ctg tgt gtg aca ctg aat tgc aca aac gct aac ctc atc aat gtg aat

FIGURE 12 (Cont)

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GAP IN SEGMENTS DUE TO HYPERVARIABLE REGIONS 1 AND 2

Y R L I N C N T S V I K Q A C P K V S F D P I P I H Y C T P	Segment 1
tac aga ctg att arc tgt aac aca agc gyt atc ama cag gct tgc cct aag rtt asc ttt gas cct atc cct atc cat tac tgt tcc cct	A
P K V S F D P I P I H Y C T P A G Y A I L K C N D K N F N G	Segment 2
I T E	N K
ccc aaa rtc wcc ttc gam ccc att ccc att cac tat tgc xct ccc gcc gga tvc gct atc ctc aag tgt aac rat aag amm ttc aat ggc	T
A G Y A I L K C N D K N F N G T G P C K N V S S V Q C T H G	Segment 3
F N K	T
gct ggc tvt gcc att ctg aaa tgc aat. rac aaa ama ttt aac gga acc gga ccc tgt amg aat gtg tcc asc gtc cag tgt acc cat ggc	
T G P C K N V S S V Q C T H G I K P V V S T Q L L L N G S L	Segment 4
aca ggc cct tgc ama aac gtc agc wcc gtg caa tgc aca cac gga atc ara ccc gtc gtg tcc acc caa ctg ctc ctg aat ggc tcc ctg	R
I K P V V S T Q L L L N G S L A E E I I I R S E N L T N N	Segment 5
att arg cct gtg gtc aca cag ctc ctg ctc aac gga agc ctc gcc gaa gag gaa rtc rtt atc aga agc gaa aac ytt acc rat aac	F D

FIGURE 12 (Cont)

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A	E	E	I	I	I	R	S	E	N	L	T	N	N	A	K	T	I	I	V	H	L	N	E	S	V	E	I	N	Segment 6
			(V)	(V)					F	D	V								Q			K			V				
gct gag gaa gat rtt rtc att agg tcc gag aat ytc aca rac aat gyc aaa acc att atc gtc cam ctc aac raa agc gtc gwg att aac																													
A	K	T	I	I	V	H	L	N	E	S	V	E	I	N	C	T	R	P	N	N	N	T	R	K				Segment 7	
V						Q			K		V				S							T							
gyc aag aca atc att gtg caw ctg aat rag tcc gtg gva atc aat tgc aca agg cct arc aat aac aca agg ama																													

FIGURE 12 (Cont)

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GAP IN SEGMENTS DUE TO HYPERVARIABLE REGIONS 3,4 AND 5

T F R P G G D I K D N W R S E L Y K Y K V V K I E P L G V	Segment 1
I N M R	
ayc ttt agg cct ggc gga ggc rat ata axa gac aat tgg aga agc gaa ctg tat aag gtc gtc rag att rag cct ctg gga rtc	
E L Y K Y K V V K I E P L G V A P T R A K R R V V E R E K R	Segment 2
E K I K Q	
gag ctc tac aaa tac gtc gtc xaa atc xaa ccc ctc ggc xtt gcc cct acc ara gcc aaa agg aga gtc gtc sag aga gag aaa agg	
A P T R A K R R V V E R E K R A V G I G A M I F G F L G A A	Segment 3
K Q L F L	
gct ccc aca arg gct aag aga agg gtc gtc gaa aag gaa agg gtc gtc ggc mtt ggc gct atg wtt ytc gga ttc ctc ggc gct gcc	
A V G I G A M I F G F L G A A G S T M G A A S I T L T V Q A	Segment 4
L F L M	
gct gtc gga mtc gga gcc atg wtc ytt ggc ttt ctg gga gcc gct ggc tcc acc atg ggc gct gcc tcc ata aca ctg aca gtc caa gcc	
G S T M G A A S I T L T V Q A R Q L L S G I V Q Q Q S N L L	Segment 5
M L N	
gga agc aca atg gga gcc gct agc atk acc ctc acc gtc cag gct agg cwa ctg ctc agc gga atc gtc cag caa cag arc aat ctg ctc	
R Q L L S G I V Q Q Q S N L L R A I E A Q Q H L L Q L T V W	Segment 6
L N M	
aga cwg ctc ctg tcc ggc att gtc caa cag caa art aac ctc ctg agg gct atc gaa gcc caa cag cat mtg ctc cag ctc acc gtc tgg	

FIGURE 12 (Cont)

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R A I E A Q Q H L L Q L L T V W G I K Q L Q A R V L A V E R Y Segment 7
 M
 aga gcc att gag gct cag caa cac wtg ctg caa ctg aca gtg tgg ggc att aag caa ctg caa gcc aga gtg ctc gcc rtt gag aga tac
 G I K Q L Q A R V L A V E R Y L K D Q K F L G L W G C S G K Segment 8
 I
 gga atc aaa cag ctc cag gct agg gtc ctg gct rtc gaa agg tat ctg aaa gac caa mag ytt ctg gga mtc tgg ggc tgt agc gga aag
 L K D Q K F L G L W G C S G K I I C T T A V P W N S S W S N Segment 9
 Q L I
 ctc aag gat cag maa ytc ctc ggc mtt tgg gga tgc tcc ggc aaa mtc att tgc aca acc rmt gtg cct tgg aac agc wcc tgg tcc aac
 I I C T T A V P W N S S W S N K S L E E I W N N M T W M E W Segment 10
 N
 mtt atc tgt acc aca xmc gtc ccc tgg aat tcc asc tgg agc aat aag tcc ytc gaa gag att tgg rat aac atg acc tgg ata maa tgg
 K S L E E I W N N M T W M E W E R E I S N Y T N Q I Y E I L Segment 11
 F D I Q
 aaa agc ytt gag gaa atc tgg rac aat atg aca tgg atk mag tgg gag aga gag att agc aat tac aca arc cwa atc tat rag att ctg
 E R E I S N Y T N Q I Y E I L T E S Q N Q Q D R N E Q E L L Segment 12
 S L K
 gaa agg gaa atc tcc aac tat acc art cwg att tac xaa atc ctc acc gaa agc caa aac caa cag gat agg aat gag maa gas ctc ctg

FIGURE 12 (Cont)

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T E S Q N Q Q D R N E Q E L L E L D K W A S L W N W F D I T Segment 13
 aca gag tcc cag aat cag caa gac aga aac gaa mag gam ctg ctc gmg ctc gac aaa tgg gct agc ctc tgg aat tgg ttt zac att aac
 K D A N S
 E L D K W A S L W N W F D I T N W L W Y I K I F I M I V G G Segment 14
 A N S K
 gma ctg gat aag tgg gcc tcc ctg tgg aac tgg ttc rat atc vcc aaa tgg ctg tgg tac att aag att ttc att atg att gtc gga ggc
 N W L W Y I K I F I M I V G G L I G L R I V F A V L S I V N Segment 15
 K V I
 aam tgg ctc tgg tat atc aaa atc ttt atc atg atc gtc ggc gga ctg rtt ggc ctc agc att rtc ttt gcc gtc ctg tcc atc rtt aac
 L I G L R I V F A V L S I V N R V R Q G Y S P L S F Q T L L Segment 16
 V I T
 ctc rtc gga ctg aga atc rtt ttc gct gtc ctc agc att rtc aat agc gtc agc caa ggc tat agc cct ctg tcc ttc caa acc ctc myc
 R V R Q G Y S P L S F Q T L L P A P R G P D R P E G I E E E Segment 17
 T L G R
 aga gtc aga cag gga tac tcc ccc ctc agc ttt cag aca ctg myc gcc gct ccc aga ggc cct gac aga cgc gra agc att gag gaa gag
 P A P R G P D R P E G I E E G G E Q D R D R S V R L V S G Segment 18
 L G R R G G N
 cct gcc cct agc gga ccc gat agc ctc gtc rga atc gaa gag gaa ggc gga gag cra ggc aga gtc agc gtc agc ctc gtc art ggc

FIGURE 12 (Cont)

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G G E Q D R D R S V R L V S G F L A L A W D D L R S L C L F Segment 19
 R G (G) N S N
 gga ggc gaa cag grt agg ggt gac aga ctg gtc arc gga ttc tya gcc ctc gcc tgg gac gat ctg aga arc ctc tgc ctc ttc

 F L A L A W D D L R S L C L F S Y H R L R D L I L I A A R I Segment 20
 S (N) F V T
 ttt tyg gct ctg gct tgg gat gac ctc agg art ctg tgt ttt agc tat cac aga ctg aga gac ytt atc ctc atc gyt gcc aga ayc

 S Y H R L R D (L) I L I A A R I V E L L G H S S L R G L R R G Segment 21
 F V T R K Q
 tcc tac cat agg ctc agg gat ytc att ctg att gyc gct agg ayt gtg gaa ctg ctc gcc crt agc tcc ctg ara ggc ctc crg aga ggc

 V E L L G H S S L R G L R R G W E A L K Y L W N L L Q Y W G Segment 22
 R K Q G W G L
 gtc gag ctc ctg gga crc tcc agc ctc arg gga ctg cra agg gga tgg gaa gac ctc aag tat tkg kgg aac ctc ctg cwa tat tgg gga

 W E A L K Y L W N L L Q Y W G Q E L K I S A V S L L N A T A Segment 23
 G W G L I
 tgg gag gat ctg aaa tac tkg kgg aat ctg ctc cwg tac tgg ggc cwg gaa ctg aaa awc tcc gcc rtt agc ctc ctg aat gcc aca gcc

 Q E L K I S A V S L L N A T A I A V A E G T D R V I E V A Q Segment 24
 L N I G W I V
 cwa gag ctc aag awt agc gct rtc tcc ctg ctc aac gct acc gct atc gct gtg gct grg kgg acc gat agg rtt atc gaa gtg gyt cag

FIGURE 12 (Cont)

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I	A	V	A	E	G	T	D	R	V	I	E	V	A	Q	R	A	G	R	A	I	L	H	I	P	R	R	I	R	Q	Segment 25
					G	W			I			V					W				N									
att gcc gtc gcc gta kgg aca gac aga rtc att gag gtc gyc caa agg gct kgg aga gcc att ctg mat atc cct aaa aga atc aga cag																														
R	A	G	R	A	I	L	H	I	P	R	R	I	R	Q	G	L	E	R	A	L	L								Segment 26	
					W				N			T					F													
aga gcc kgg agg gct atc etc mac att ccc aag agg att agg caa ggc ytt gag aga gcc ctc ctg																														

FIGURE 12 (Cont)

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NEF OVERLAPPING SEGMENTS

M G G K W S K S S L V G W P E V R E R I R Q T P P A A E G V	Segment 1
atg gga ggc aaa tgg tcc aag wgc tcc cgc gtc gga tgg ccc gma gtg aga atc aga crg rca acc cct gcc gct gag gga gtg	
V R E R I R Q T P P A A E G V G A V S Q D L D K H G A I T S	Segment 2
gtc agg gaa agg att agg cra rcc acc cct gcc gtc ggc gtc ggc gct gyc tcc crg gat ctg gat aag kac gga gcc mtc acc tcc	
G A V S Q D L D K H G A I T S S N T P A N N A D C V W L K A	Segment 3
gga gcc gys agc cra gac ctc gac aaa kat ggc gct mtt aca agc tcc aat acc act gcc aat aac act gac tgt gyc tgg ctc rag gct	
S N T P A N N A D C V W L K A Q E E E G V G F P V R P Q V P	Segment 4
agc aac aca acc gct aac aat acc gat tgc gys tgg ctg xaa gcc cag gaa gag gaa gra gtg gga ttt cct gtg aga ccc caa gtg cct	
Q E E G V G F P V R P Q V P L R P M T Y K G A F D L S F F	Segment 5
caa gag gaa gag gtg gtc ggc ttc ccc gtc agg cct cag gtc ccc ctg aga cct atg acc tac aaa gaa gcc rtc gat ctg tcc ytc ttc	
L R P M T Y K G A F D L S F L K E K G G L E G L V Y S K K	Segment 6
ctc agg ccc atg aca tat aag gac gct rtt gac ctc agc ycg ttt ctg aaa gag aaa ggc gga ctg gaw ggc ctc rtc tat agc mag aaa	

FIGURE 12 (Cont)

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L K E K G G L E G L V Y S K K R Q E I L D L W V Y H T Q G F Segment 7
 ctc aag gaa aag gga ggc ctc gaa gga ctg rtt tac tcc maa aag agg caa gas att ctg gat ctg tgg gtg tat mac aca cag gga twc
 R Q E I L D L W V Y H T Q G F F P D W H N Y T P G P G I R Y Segment 8
 (D) N Y Q T V
 aga cag gaw atc ctc gat ctc tgg gtc tac mat acc caa ggc twt ttc cct gac tgg cas aat tac aca ccc gga ccc gga ryc aga tac
 F P D W H N Y T P G P G I R Y P L T F G W C F K L V P V D P Segment 9
 Q T V
 ttt ccc gat tgg caw aac tat acc cct ggc cct ggc rya agg tat ccc ctc acc ttt ggc tgg tgc ttt aag ctc gtc cct gtc gat ccc
 P L T F G W C F K L V P V D P R E V E I N K G E N N C L L Segment 10
 cct ctg aca ttc gga tgg tgt ttc aaa ctg gtc ccc gtc gac cct ags gaa gtc gaa gag ryc aac raa ggc gaa aac aat tgc ctc ctg
 R E V E E I N K G E N N C L L H P M S Q H G M E D E R E V Segment 11
 S A E I C L D
 agw gag gtc gag gaa ryc aat rag gga gag aat aac tgt ctg ctc cac cct ats tgt cwg cat ggc atg gaa gac gaa gas aga gag gtc

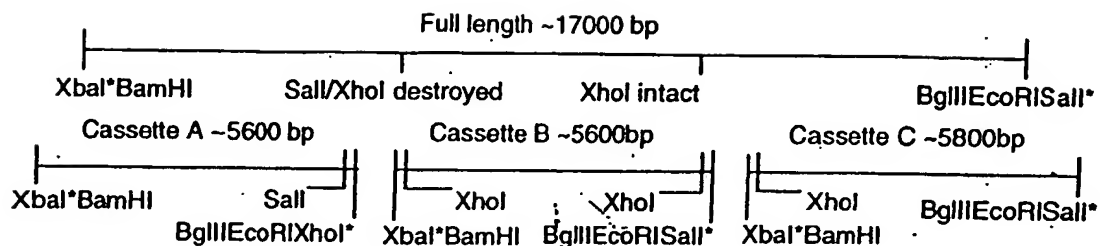
FIGURE 12 (Cont)

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H P M S Q H G M E D E R E V L I W K F D S R L A R R H I A	Segment 12
I C L	
cat ccc ats tgc cwa cac gga atg gag gat gag gag gag gaa gtg ctg awa tgg aaa ttc gat agc crt ctg gct ckc agg cat ats gct	
L I W K F D S R L A R R H I A R E L R P E F Y K D C	Segment 13
K	
ctc awa tgg aag ttt gac tcc crc ctc gcc ckg aga cat ats gcc agg gaa ctg crt ccc gaa twc tac aaa gac tgc	

FIGURE 12 (Cont)

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Full length construction after cloning the cassettes into pBS.
 Sites marked with a "*" are in the pBS MCS

Cassette Extras (Can be removed from cassette ends)

A (37bp)	BamHI/Kozak Start	Sall	Stop	BglII	EcoRI
5'	gc ggatccacc atg.....	....gtcgac	tga	agatct	gaattc gc 3'
B (43bp)	BamHI/Kozak Start XhoI	XhoI	Stop	BglII	EcoRI
5'	gc ggatccacc atg ctcgag...	....ctcgag	tga	agatgt	gaattc gc 3'
C (37bp)	BamHI/Kozak Start XhoI	Stop	BglII	EcoRI	
5'	gc ggatccacc atg ctcgag...tga	agatct	gaattc gc 3'	

FIGURE 14

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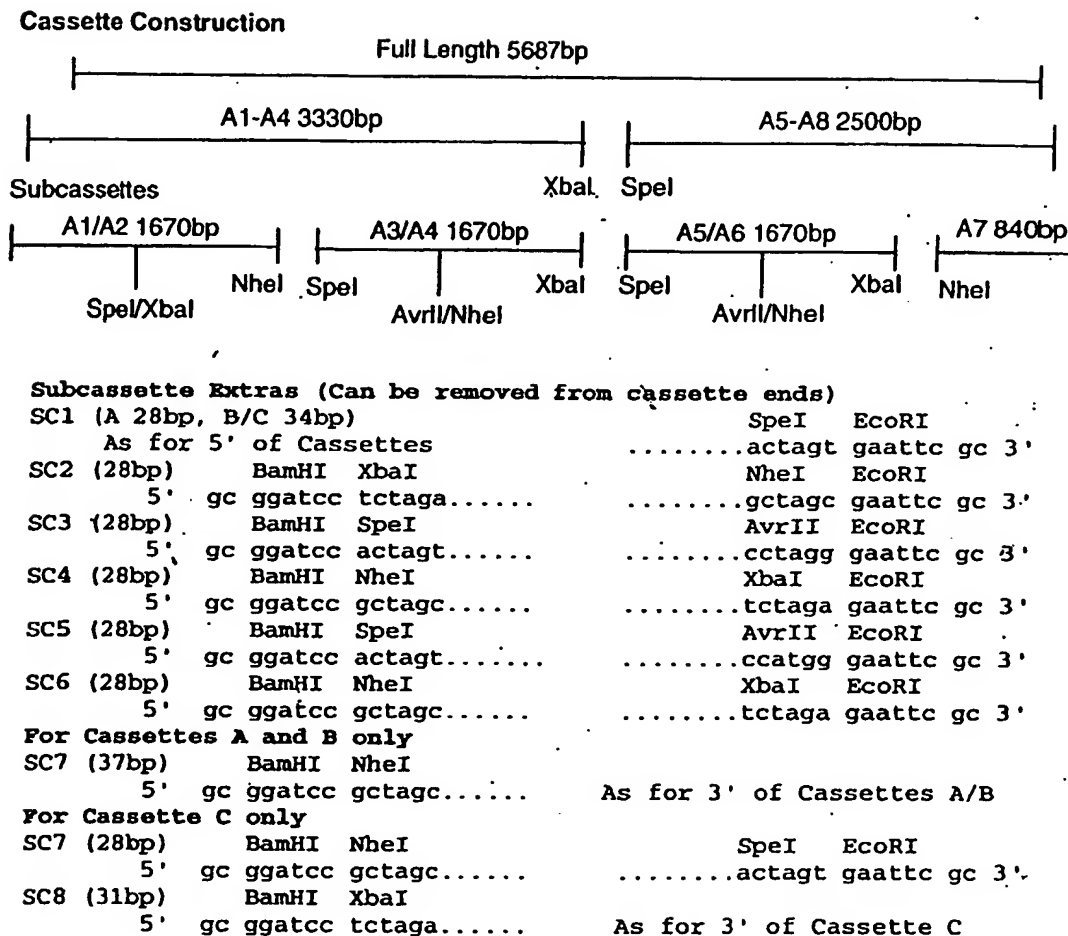


FIGURE 14 (Cont)

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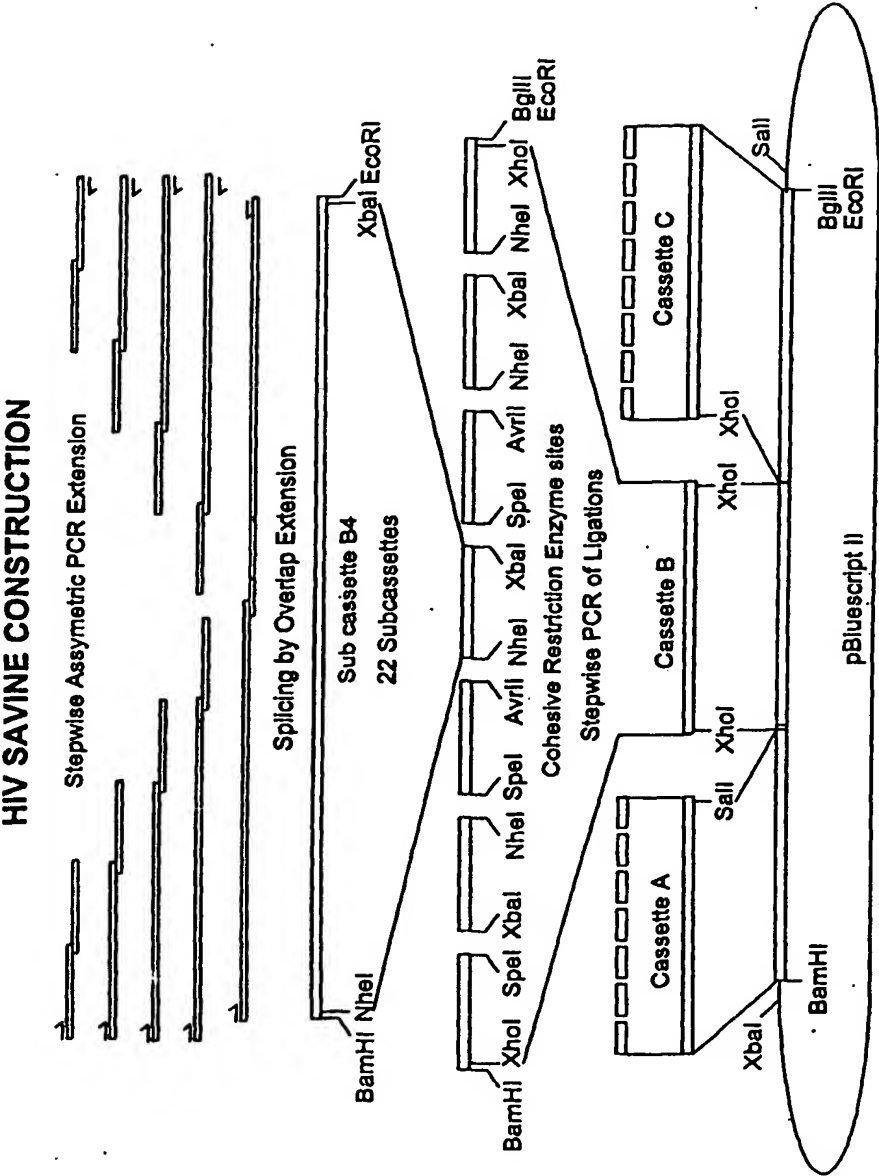


FIGURE 14 (Cont)

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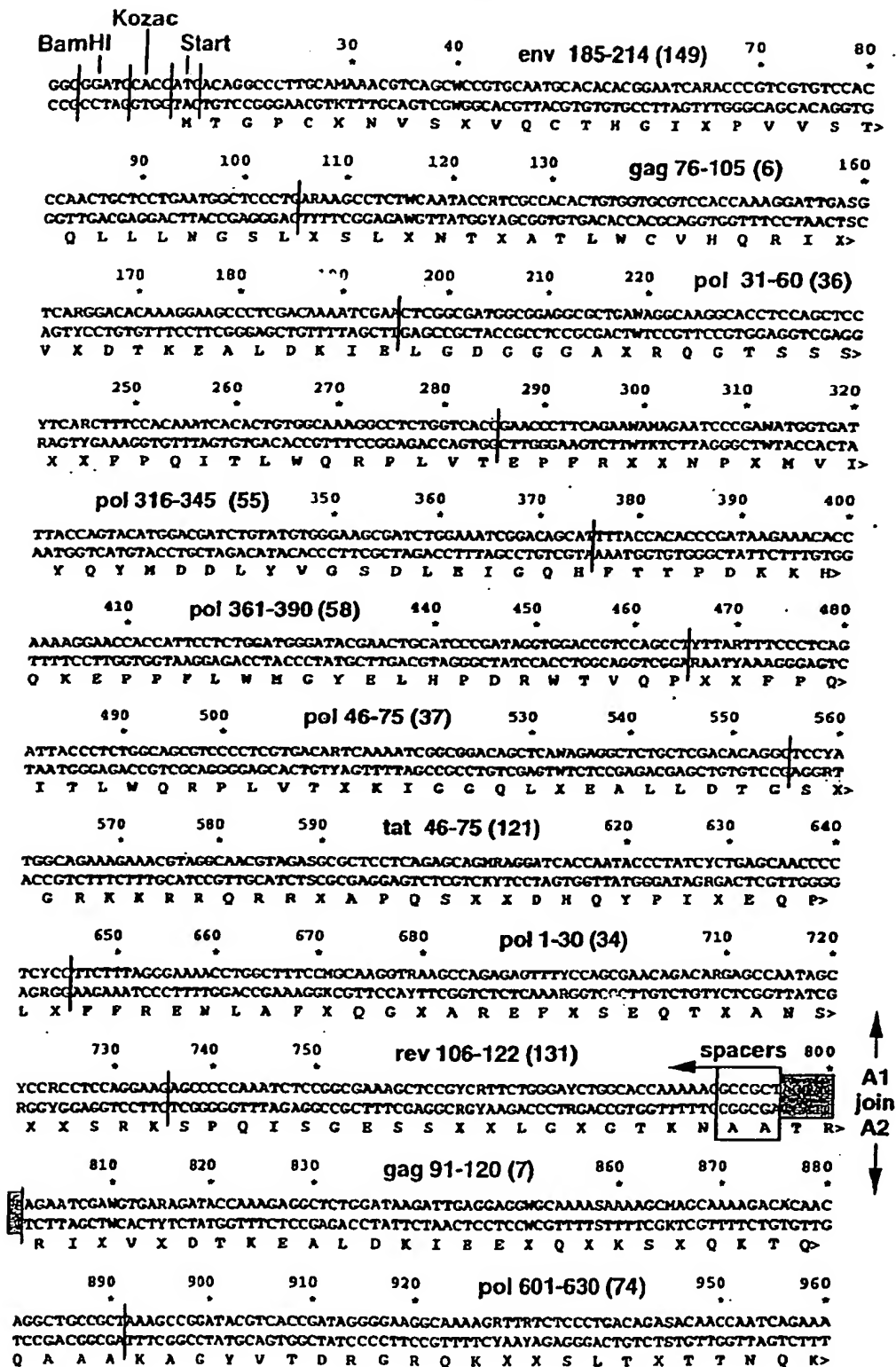


FIGURE 15

SUBSTITUTE SHEET (RULE 26)

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970 980 990 1000 1010 env 46-75 (140) 1040
ACCGAACTGCAGGCCATTCAGGAGCCRHATACCACTGTTTTGGCCGAGCGATGCCAAGCCYATGASACAGAGGTCCA
TGGCTTGACGTWCGGTAAAGTCTKCGYKATGGTGTGACAAAACGGGTGCGCTACGGTTTCGGRTACTSTGTCTCCAOGT
T E L X A I X X A X T T L P C A S D A K A X X T E V H>

1050 1060 1070 1080 1090 pol 76-105 (39) 1120
CAATGTGTGGGCACACACGCTTGCCTCCCGCTGACGATACAGTGTGGAGGASATSAACTCCCGGAARATGGAAGC
GTTACACACCCGGTGTGTGCGAACGACGGCGGCACTGCTATGTCACGACCTCTTASTTGGAGGGCCCTTTACCTTCG
N V W A T H A C V P A D D T V L E X X M L P G X W K>

1130 1140 1150 1160 1170 1180 1190 1200
CTAAGATGATTGGCGGAATCGGCGATTTCATTAAAGGTGAGFARGATCGGACCCGAAAACCTTACAATACCCARTCTTC
GATTCTACTAACCGCCTTAGCCGCTAAGTAATTCACCTCTTCTAGCCTGGGCTTTTGGGAATGTTATGGGGTYAGAAG
P K M I G G I G G F I K V R X I G P E N P Y N T P X P>

pol 196-225 (47) 1230 1240 1250 1260 1270 1280
GCTATCAAGAAAAAGGACTCCACCAATGGAGAAAGCTCGTGGATTTCAGFRTTAGGATTATCAANATCCTCTACCAAG
CGATAGTTCTTTTCTGAGGTGGTTTACCTCTTTGAGCACCTAAAGTCFYAATCCTAATAGTTWTAGGAGATGGTTTC
A I K K K D S T K W R K L V D P R X R I I X I L Y Q S>

1290 rev 16-45 (125) 1320 1330 1340 1350 1360
CAATCCCTATCTAGCTCCGAAGGCMCAGGCAARCCAGAARGAATAGGAGAAGGAGATGGGGAGGCCAACRGRTAGGG
GTTAGGGATAGGATCGAGGCTTCGGGGTCCGTTTGGTCTTCTATCTCTTCTCTTACCTCCGCTTGCTGCTATCCC
N P Y P S S E G X R Q X R X N R R R R W O G E X X R>

1370 1380 env 525-554 (171) 1410 1420 1430 1440
ATAGGTCCGTGAGACTGGTCARCCGATTCCTYAGCCCTGGGCTGGGACGATCTGAGAARCCCTCTGCTCTTGAMAACTC
TATCCAGGCACTCTGACCACTYCCCTAAGARTCGGAGCGGACCTCTGCTAGACTCTTGGAGACGGAGAAGCTKTGGAG
D R S V R L V X G F X A L A W D D L R X L C L P X N L>

1450 1460 1470 env 31-60 (139) 1500 1510 1520
TGGGTCAACCGTCTACTATGGCGTCCCGTCTGGAGAGASGCTTRMCACAAACCTCTTCTGTGCTCCGACCGCTAAGGCTYA
ACCCAGTGGCAGATGATACCGCAGGGGACGACCTCTCTSCGAYKGTGTGGGAGAAGACACGGGACCGCTCCGATTCCGART
W V T V Y Y G V P V W R X A X T T L P C A S D A K A X>

spacers 1550 1560 rev 1-30 (124) 1590 1600
CGCTGCCATGGCTGGCAGAGCGGCTCACAGACGAAGAGCTCCTGARGGCTRTCAGAATCATTAAATTCGTATCAGT
CGCAGGCTACCGACCGTCTCCCGYGTGCTGCTTCTCGAGGACTYCCGA YAGTCTTAGTAATTSTAGACATAGTCA
A A M A G R S G X T D E E L L X A X R I I X I L Y Q>

1610 1620 1630 1640 1650 vif 16-45 (101) 1680
CCAACCCCTTACCCTTCCGATGARAATCAGAACCTGGAASAGCCTGGTCAAGCATCACAICYACATCTCCAAGAAA
GTTTGGGAATGGGAAGGCTGCTTACTTCTGACCTTSTCGGACCACTTCGTAGTGTACTGTAGAGGTTCCTT
S N P Y P S A S M X I R T W X S L V K H H M X I S K K>

1690 1700 1710 1720 1730 1740 1750 1760
GCCAAGGGCTGCTTCTATAGGCATCACTWTGASGAGTCCGAGSTCGTGARTCAGATTATCGAAVAGCTCATCAAAAAGGA
CGGTTWCGGACCAAGATATCCGTAGTCAACTSTCAGGCTCSAGCACTYACTCTAATAGCTTBTCCAGTAGTTTTCCT
A X G W P Y R H H X X E S E X V X Q I I E X L I K K E>

pol 661-690 (78) 1790 1800 1810 1820 1830 1840
AARGGTCTACCTAKCATGGGTACCAGCCCAAGGGAATCGGCAAAACCAAGAGCTCCAGAAMCAGATTTHYCAAAATCC
TTCACAGATGGATMGATACCTATCGGTGTTCCCTTAGCCTGTTTGGTTTCGAGGCTCTTGTCTAAKRGTTTTAGG
X V Y L X W V P A H K G I G Q T K E L Q X Q I X K I>

1850 pol 916-945 (95) 1880 1890 1900 1910 1920
AAAATTTAGGGTCTACTATAGGGATAGCAGAGACCTTCTGGAGGGACCCAAAAGCYTTGAGGAATCTGGRACAAT
TTTGAATCCAGATGATATCCCTATGCTCTCGGAGAGACCTTCCCTGGCTTTTCGAACTCCTTTAGACCTGTTA
Q H P R V Y Y R D S R D P X W K G P K S X E E I W X N>

A2
join
A3FIGURE 15 (Cont)
SUBSTITUTE SHEET (RULE 26)

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1930 env 405-434 (163) 1960 1970 1980 1990 2000
ATGACATGGATKSAGTGGGAGAGAGATTAGCAATTACACAARCCWAATCTATRAGATTCTG|ARACCCGAACCCACAGC
TACTGTACCTAHSTCACCTCTCTCTCTAATCGTTAATGTGTTGGWTTAGATAYTCTAAGACT|TGTGGCTTTGGGTGTCG
M T W X X W E R E I S N Y T X X I Y X I L X P E P T A>
2010 2020 gag 451-480 (31) 2050 2060 2070 2080
CCCTCCCGCTGAGARTTTCRGATTCCGTGAGGAACTACACCCCTCC|HAAAGCAAGAGCAAAAGGATAAGGACCAATACG
GGCAGGGCGGACTCTYAAAGYCTAAGCCACTCTTTGATGTGGGAGGGKTTTCGTTCTCGKTTTCTATTCTCT|GTTATGC
P P A E X P X P G E E T T P S X K Q E X K D K E Q Y>
2090 2100 2110 pol 106-135 (41) 2140 2150 2160
ATCAGATTMTTATTGAGATTTCGGCCAAAGAAAGCTATTGCTACAGTCTCGTGGGACCTACCCCTGTGAATATCATTTGGC
TAGTCTAAKATAACTCTAAACGCCCTCTCTTCGATAACCATGTCACGAGCACCCTGGATGGGGACACTTATAGTAACCG
D Q I X I E I C G K X A I C T V L V G P T P V N I I C>
2170 2180 2190 2200 vpr 46-75 (115) 2230 2240
AGTATTACGAAACCTATGGCGATACCTGGGAGGGCGTCGAGGCTCTGATCAGAA|YCTCCAGCAACTGTTGTTTTCCTCA
TCTTAAATGCTTTGGATACCGCTATGGACCTCCCGCAGCTCCGAGACTAGTCTT|TGGAGGTCGTTGACKACAAAYAGGT
R I X Y E T Y G D T W E G V E A L I R X L Q Q L X F X H>
2250 2260 2270 2280 2290 tat 31-61 (120) 2320
TTTCAGAAATCGG|TCTTTCATTGCCAATGCTGTTTCTCACC|AAAGCTCTCGGCATTAGCYACGGAAGGAAAAAGAGAA
AAAGCTTACGCTTACAAWAGTAACGGTTSACACAAAGAGTGGTTTCCAGACCCGTAATCGTGCCTTCTTTTCTCTT
P R I G C X R C Q X C F L T K G L G I S X G R K K R>
2330 2340 spacers 2370 2380 tat 1-30 (118)
RACAGAGAAGGSGAGCTCCCCA|GCTGCCATGGACCCCGTGGACCCCAASCTGGAGCCTTGGAAWCAACCTGGCTCCCCAG
YTCCTCTCTCCSCTCGAGCGGTTCGACGCTACCTGGGGCACCCTGGGCTTSGACTCGGAACCTTWTGGGACCGAGGGTC
X Q R R X A P Q A A M D P V D P X L E P W X H P G S Q>
2410 2420 2430 2440 2450 2460 2470 2480
CCTAHGACAGCCTGTWCAAAATGCTATTGCAAAAAGTG|GAAGAGACAAACCTAGCCMGAAACAGGAACHGAA
GGATKCTGTCGGACAWKGTTTACGATACGTTTTCAC|CTTCTCTGTTGGGATCGGKCTTTGTCCTTGKCTT
P X T A C X K C Y C K K C P S B E T T P S X K Q E X K>
gag 466-495 (32) 2510 2520 2530 2540 2550 2560
AGACAAAGAACMCACCCCTT|YAGCCAGCCTCAAGTCCCTGTTTGGCAATGAA|AATTTCAATATGCGAAGAATRACA
TCTGTTTCTTGGATGGGGGAARTCGGTCCGAGTTCAGGGACAAACCGTTACTGTTAAAGTTATACACCTTCTAYTGT
D K E X Y P P X A S L K S L P G N D N F N H W K N X>
2570 env 91-120 (143) 2600 2610 2620 2630 2640
TGGTGGAMCAGATGCAMGAAGACTTATCTC|ACTATGGGACCAAGCCTCAAGCCTTGGCTCAAGCTCGACCTCGGGCAT
AOCACCTKGTCTACGTCCTCTGYAATAGAGTGTATCCCTGGTTTCGGAGTTCGGAAACGCACTTCGAGCTGCAGCCGCTA
H V X Q H X E D X I S L W D Q S L K P C V K L D V G D>
2650 2660 pol 256-285 (51) 2690 2700 2710 2720
GCCTATTCTCCGTGCTCTGGMTRARRCTTCAGAAAGTATACCGCTTT|CACAAATCCCTAGCAYAAACAATGAGCAACT
CGGATAAAGAGGCACGGAGACCTATTTYYGAAGTCTTTCAATATGCGGAAAGTGTAGGGATCGT|TTTGTACTGTTGA
A Y P S V P L D X X P R K Y T A P T I P S X N N E Q L>
2730 2740 2750 pol 751-780 (84) 2780 2790 2800
GAAAGCGGAAGCCATSCATGGCCAAGTGRATTGCTCACCAGGCATT|TGGCAACTGGATTGCACACACCTGGAGGGAAACR
CTTTCGCTTCGGTASGTACCGTTTACYTAAAGAGTGGTCCGTAACCGTTGACCTAACGTCGTGACCTCCCTTTCTY
K G E A X H G Q V X C S P G I W Q L D C T H L E G K>
2810 2820 2830 2840 pol 166-195 (45) 2870 2880
TTATCCCTAAGGTCAAGCAATGGCCTCTGA|CAGAGGAAAAAGATTAGGCTCTGACTG|HGATTTCAMAGAGATGGAGVAA
AATAGGGATTCCAGTTCTGTTACCGGAGACTGTCTCTTTTCTAATTCGAGACTGACKCTAAACGTCTCTACCTCBTT
X I P K V K Q W P L T E E K I K A L T X I C X E H E X>

A3
Join
A4

FIGURE 15 (Cont)

SUBSTITUTE SHEET (RULE 26)

1890 2900 2910 pol 331-360 (56) 2940 2950 2960

GACGGAAAGATTACGATGACCTCTACGTCGGCTCCGACCTGGAGATTGGCCAACTAGGRCACAAATCGAAGAGCT
CTCCCTTTCTAATCTTACCTACTGGAGATGCAGCCGAGGCTGGACCTCTAACCGGTGTATCCYGGTTTATGCTTCTCGA
E G K I S M D D L Y V G S D L E I G Q H R X K I E E L>

2970 2980 2990 3000 pol 616-645 (75) 3030 3040

CAGGSHACACCTCTGARATGGGGCTCACCCGAMACCACAAACCAAGACTGAGCTCCAMGCTATCCAWCTGGCTCTGC
GTCSSRTGTGGAGACTTTACCCCTGAGTGGCTKTGGTGTGGTTTCTGACTCGAGGTTCGATAGGTWAGCCGAGACG
R X H L L X W G L T X T T N Q K T E L X A I X L A L>

3050 3060 3070 3080 3090 pol 796-825 (87) 3120

AAGACTCCGGCTYAGAGGTCAACATTCTGACAGATATCCCGCTGACACTGGTCAAGACAGCCGCTATTTCTTTCTGAAA
TTCTGAGGCCGARTCTCCAGTGTGAACACTCTCTTAAGGCCCACTCTGACCAGTTCTCTGCGCGATAAAGKAAGACTTT
Q D S G X E V N I V T D I P A E T G Q E T A Y F X L K>

3130 3140 3150 3160 3170 3180 3190 3200

CTGGCTGGCAGATGGCTGTGARARYCATTACACAGACAAATGGAGGACAAAGATTGAGGAAGTCTGAGASHGCATCTGCT
GACCGACCTCTACCGGACACTTCTGTGAAGTGTCTGTCTACCTCTCTGTTTCTAACTCTTGACTCTSKCGTAGACGA
L A G R W P V X X I H T D N G R T K I E E L R X H L L>

pol 346-375 (57) 3230 3240 3250 3260 3270 3280

CARATGGGGCTTACAAACCCCTGACAAAAAGCATCAGAAAGAGCTCCCTTTCTCTCTCAAGAAACTGACAGAGG
GTYTACCCCGAAGTGTGGGGACTGTTTTCTGTAGTCTTTCTCGGAGGAAAGAGTCTCAGTCTCTTGACTGTCTCC
X W G F T T P D K K H Q K E P P P L S S V K K L T E>

3290 vif 166-192 (111) 3320 3330 spacers 3360

ATARGTGGAAACRAACCCAGAAAAAYCAAGGGACACAGRAAATCACAAATGAATGCCATCTCTGCCACAGAGTCCCAG
TATYCACCTGTGTGGGGCTCTTTGTGTCCTCTGTCTCTCTTTAGTGTGTACTTACCGGTACACCGCTCTCTCAGGGCT
D X W N X P Q K X X G X R X N H T M N G H A A T E S Q>

3370 3380 env 435-464 (165) 3410 3420 3430 3440

AATCAGCAAGACAGAAACGAAMAGGAMCTGCTGGAGCTCGACAAATGGGCAAGCCTCTGGAATGGTTTACATTASCA
TTAGTCTGTTCTGCTTTGCTTCTCTTGACAGACCTCGAGCTGTTTACCCGCTCGGAGACCTTAAACAAATGTAAATSC
N Q D R N E X X L L X L D K W A S L W N W P X I X D>

3450 3460 gag 121-150 (9) 3500 3510 3520

CACCGGAARTAGCTCCAAAGTGTCCCAAGTTACCCCTATCTCCAGATSYCCAAGGCCAAATGGTCCACCAASCCCTCT
GTGCCCTTATCGAGGCTTACAGGGCTTAAATGGGATAGCAGGCTTASRGGTTCGGTTTACAGGTGTTSGGKAGA
T G X S S X V S Q N Y P I V Q N X Q G Q M V H Q X X>

3530 3540 3550 3560 env 480-509 (168) 3590 3600

CCCCCAGCTCTCTCGGACTGAGAATCTTTTCGCTGTCTCAGCATTCTCAATAGGGTCAGGCAAGGCTATAGCCCTCTG
GGGGCTCAGYAGCTGACTCTTAGYAAAGCCACAGCTGTAAYAGTTATCCAGTCCGATCCGATATCGGAGAC
S P R L X G L R I X P A V L S I X N R V R Q G Y S P L>

3610 3620 3630 3640 3650 vif 106-135 (107) 3680

TCTTCCAAACCTCTCTCATCCATCTGYAMTACTTTGACTGTTTCTCTGACTCTCCCATTAGGAGAGCCATCTCTGG
AGGAAGGTTTGGAGKRCAGTAGGTAGACRTWATGAACACTGACAAAGHACTGAGGYGGTAATCTCTCGGTAGGACCC
S P F T G L X L I H L X Y F D C P X D S X I R R A I L G>

3690 3700 3710 3720 3730 3740 3750 3760

ACASAKAGTGAGHAGGAGATGCGAATAGCTGTGGGAMTCGGAGCCATGWTCTTCTGGCTTCTGGGTGCGCTGGCTCCA
TGTSTHTCACTKCTCTCTACGCTTATCGACACCTAGGCTCGGTACWAGRAACCGAAAGACCCAGCGGACCGAGGT
X X V A A S X T L T V Q A Y D P S K D L X A E I Q K Q>

env 300-329 (156) 3790 3800 3810 3820 3830 3840

CCATGGGGCGCTGCCCTCCATSACTGACAGTGCAGGCTATGACCTTAGCAAAAGACCTCTTGTGCTGAGATTGAGAAACAG
GGTACCCCGCAGCGAGGTASTGTGACTGTCACTGCTTCCGATCTGGGATCGTTCTGGAGYAAACGACTCTAAGCTCTTGTG
T M G A A S X T L T V Q A Y D P S K D L X A E I Q K Q>

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pol 466-495 (65) 3870 3880 3890 3900 3910 3920
GGTCAGGRTCAGTGGACATWTCAGATTWCCAAGACCTTTCAAAAAGGAACCGTCCTGGTCGGCCCTACACCCGTCAA
CCAGTCCTAGTCACCTGTANAGTCTAAAWGGTTCCTGGAAAGTTTTCCTTGGCAGGACCAGCCGGGATGTGGGCAGTT
G Q X Q W T X Q I X Q E P F K N G T V L V G P T P V N>

3930 pol 121-150 (42) 3960 3970 3980 3990 4000
CATCATCGGAAGGAACHTGCTGACACAGHTTGGCYGCACCTCAACTTTCCATTAGGAAGGCAGCCCTGCTATCTTTC
GTAGTAGCCTTCCTTGKACGACTGTGTCAACCGRCGTGGGAATTGAAAGGGTAATCTTTCCGTCCGGACGATAGAAA
I I G R N X L T Q X G X T L N P P I S K G S P A I F>

4010 4020 pol 301-330 (54) 4050 4060 4070 4080
AGTCCAGCATGHCAMAGATTCTCGAGCCCTTTTAGCAWMAAAACCCCTGASATGCTCATCTATCAGTATCCTCTG
TCAGGTCTGACKGTCTTAAGACCTCGGAAAATCCTTNTKTITGGGACTSTACCAGTAGATAGTCATGAGGAC
Q S S M X X I L E P F R X X N P X M V I Y Q Y P S P L>

4090 4100 4110 nef 136-165 (188) 4140 4150 4160
ACATTCCGATGGTGTTCAAACTGGTCCCGTGGACCCAGSGAAGTGGAGAGRYCAACRAGCGGAAAAACAATTGCTT
TGTAAAGCTACCAAAAGTTTGACCGGGGACCTGGGGTCTCTTCACTCTCTYRGTGTGTCCTGCTTTGTGTAACGGA
T F G W C F K L V P V D P X E V E E X N X G E N N C L>

4170 4180 4190 4200 pol 271-300 (52) 4230 4240
CCTCTTTAGCAAAATACACAGCCTTTACCATTCCCTCCAYCAATAACGAAACCCCTGGCATTAGGTATCAGTATAACGTC
GGCAAAATCCTTTATGTCTCGGAAATGGTAAGGGAGGTGTATTGCTTTGGGACCGTAATCCATAGTCATATGCGAG
L F R K Y T A F T I P S X M N E T P G I R Y Q Y N V>

4250 4260 4270 4280 4290 env 315-344 (157) 4320
TGCTCAGGATGGGAAGCACAATGGGAGCCGCCAGCATKACCTTCACCGTCCAGGCTAGGCNACTGCTCAGCGGAATC
ACGGAGTCCCTACCCCTTCTGTTACCTCGCCCGTCTGATGGGAGTGGCAGGTCCGATCCGWTGACGAGTCCGCTTAG
L P Q G W G S T M G A A S X T L T V Q A R X L L S G I>

4330 4340 4350 4360 4370 pol 451-480 (64) 4400
GTCCAGCAACAGARCAATCTGCTGGGAGAAATAGGGAATCCTCARAGAGCCTGTGCATGGCTCTACTACGATCCCTC
CAGGTCTGTCTGTGTTAGACGACCTCTTATCCCTTTAGGAGTTCTCGGACACGTACCCGAGATGATGCTAGGGAG
V Q Q Q X M L L X E N R E I L X E P V H G V Y Y D P S>

4410 4420 4430 4440 4450 vpu 61-81 (136) 4480
CAAGGATCTGRTCCCTGAATCCAAAAGCAAGCASAAGAGGAAGTCTCCRCCTGGTGGATATGGGAACTACGACCTCG
GTTCTTAGACYAGCGACTTATGCTTTTCTGTTCCCTSTCTCCTTGACAGGYGMAACCACTATACCTTTGATGCTGGAGC
K D L X A E X Q X Q G X E E L S X X V D M G N Y D L>

spacers 4510 4520 4530 vpr 61-90 (116) 4560
GAGTGGACAAATACCTGCCCTATTAGAAYCCTGCAACAGCTCTGTTCRTTCACTTTAGGATTGGCTGCCRCGACTCC
CTCACCTGTTATTGGACCGCGTAATCTTGGACGTTGTGCGAGKACAAGTAAGTGAATCCTAACCGACGGYCGTGAGG
G V D N N L A A I R X L Q Q L X F X H P R I G C X H S>

4570 4580 4590 4600 4610 gag 406-435 (28) 4640
ACGATTGGCATCHYCCGTAGAGAAGGGSCAGGCTCCAGGAAAAGGGATGCTGGAAGTGTGGCARAGCGGACACCA
TCCTAACCGTAGKRGGCAGTCTCTCCSGTCTCGAGGGTCCCTTTTCCCTACGACCTTCACACCGTCTCTCCCTGTGCT
R I G I X R Q R R X R A P R K K G C W K C G X E G H Q>

4650 4660 4670 4680 4690 4700 4710 4720
GATGAAGGATTGCACTGAGACAGGCTAACTTTCTGGGAAAGCAAGCCAGACTGRTTATCARAACCTATTGGGACTEC
CTACTTCTTACCTGACTCTCTGTCGATTGAAAGACCTTTCTTCCGCTGACYAATAGTYTTGGATAACCCCTGAGC
M K D C T E R Q A N F L G K X A R L X I X T Y W G L>

vif 61-90 (104) 4750 4760 4770 4780 4790 4800
ATACCGGTGAGAGAGACTGGCASCCTCGGCCAWGCCGTGACATTGAGTGGAGCAAYAGGGAAAGGGCTGAGGATAGCGGC
TATGGCACTCTCTGACCGTSGAGCCGGTWCAGCTGTAACCTACCTCTTCTCCCTTTCCGACTCTTATCGCCC
H T G E R D W X L G X G V S I E W R X R E R A E D S G>

A5
join
A6

FIGURE 15 (Cont)

SUBSTITUTE SHEET (RULE 26)

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vpu 46-75 (135) 4830 4840 4850 4860 4870 4880

AACGAAAGCGAAGGCAGSAGAAGAGCTCAGCRCANTGGTGGACATGGGCATTACGACTCTGTTACAGCTCCGCCCCAG
TTGCTTTCGCTTCGCTGTSTCTCTTCGAGTCGYGTWACCACCTGTACCCGTTAATGCTAGACCTGTTGGACGGGGGTC
N E S E G D X E E L S X X V D M G N Y D L S S P A P R>

4890 env 510-539 (170) 4920 4930 4940 4950 4960

GGGACCCGATAGGCGYGRGRGAATCGAAGAGCAAGCCGAGAGCRAGRCAGAGRCAGAACCGTCAAGGCTCGTGARTCGA
CCCTGGGCTTCCGCCCYCTTAGCTTCTCTTCCCGCTCTCGYTCTCTCTCTCTCTCGAGTCGAGCACTYACCTT
G P D R X X X I E E E G G E X X R X R S V R L V X G>

4970 4980 nef 151-180 (189) 5010 5020 5030 5040

CWGAGGTGCGAARAYCASTRAGCGAGAGATAACTGTCTGCTCCACCCTATSRGTCHACATGGCATGGAAGACGAAGAS
CWCTCCAGCTCTCTTYRGTAYTCCCTCTCTTATTACACAGCAGGCTGGGATASYCAGWTGTACCGTACCTTCTGCTTCS
X E V E E X N X G E N . N C L L H P X X X H G H E D E X>

5050 5060 5070 pol 961-990 (98) 5100 5110 5120

AGAGAGGTTAATAGCGATATCAAAGTGGTCCCCAGAAAGGAAGCCAAAATCATTAGGGAATTACGGAAAGCAATGGCTGG
TCTCTCCATTTATCGCTATAGTTTACCAGGGGCTTCTCTTCGGTTTTAGTAAATCCCTAATGCCCTTTCGTTTACCGACC
R E V N S D I K V V P R R K A K I I R D Y G K Q M A G>

5130 5140 5150 5160 pol 16-45 (35) 5190 5200

CGHTGACTGTGTGGCCRGCTTCTCTTCCGAGCAACARGGGCTAACTCCCTCTCAAGCAGAAAGCTGGGAGACGGAGGGC
GCKACTGACACACCGGYCAAGRAGAGCTCGTTTGTGCCGATTGAGRGAYTTCTCTTTCGACCTCTGCTCTCCG
X D C V A X F X S E Q T X A N S X X S R K L G D G G>

5210 5220 5230 5240 5250 gag 390-420 (27) 5280

GAGCCGASAGACGGGAACAGCTCCAGCTGTTCATTTGGCGGCAAGAGGGACACHTTGCCARAACTGTAGGGCCCCCT
CTCGGCTSTCTCTCCCTTCTCTGAGGTCTCAAAAGTTAAAGCCGTTTCTCTCTCTGKAACGGTTTTTGACATCCC GGGA
G A X R Q G T S S S C P W C G K E G H X A X N C R A P>

5290 5300 5310 5320 5330 5340 5350 5360

CGCAAGAAAGGTGTGTGGAANTCGGAARGGAAAGCCATCAAAATGAAAGACTGTACCGAAAGGCAAGCCAATTTCTCTCGG
GGCTTCTTTCCCAACCTTTAGCGCTTCTCTCCGGTGTATTACTTTCTGACATCGCTTCTCCGTTCTCGTTAAAGGAGCC
R K K G C W K C G X B G H Q M K D C T E R Q A N F L G>

gag 421-450 (29) 5390 5400 5410 5420 5430 5440

CAAAATCTGGCCCTCCHRCAMGGCAGACCCGAAACTTTTCYCCAAAGCAAAATGGCTCTGGTATATCAAAATCTTTATCA
GTTTITAGACGGGAGKYGTTTCCGCTCGGCCCTTCAAGRGGTTCTTACCGGACCATATAGTTTtagaaatagt
K I W P S X K G R P G C N F X Q S X W L W Y I K I P I>

5450 env 465-494 (167) 5480 5490 5500 5510 5520

TGATCGTCCGTTGACTGRTTGGCCCTCAGGATTTCTTTGCCGCTCTGTCCATCRTTAAAGGAGCCGYGAGCCRAGACCTC
ACTAGACCCACTGCACYAACCGGAGTCTTAAYAGAAACGGCAGCACGCTAGYAATTCCTCGGCRCTCGGYTCTGGAG
M I V G G L X G L R I X F A V L S I X N G A X S X D L>

5530 5540 nef 31-60 (181) 5570 5580 spacers

GATAAACATGGCCCTHTTACAAGCTCCAAATACCSCCTGCCAAATACSCCTGACTGTGYCTGGCTGRAGGCTGCTGCGATGAC
CTAITTGTACCGGAGAAATGTTGAGGTTATGGGACCGTTATTGSACTGACACRAGCCAGCTCCGCGGAGCTGACTG
D K H G A X N T X A N W X D C X W L X A A A M T>

5610 5620 5630 vpu 1-30 (132) 5660 5670 5680

ACCCTCGGAGATCATCGCTATCGTCCGCTTATCGTCCGCTCATCTHAGCCATTGCTGCTCGGACAAATCGYCTWCATTG
TGGGGACCTCTAGTAGCGATACCGGGAATAGCAGCCGGAGTAGKATCGGTAACACAGACCTGTTAGCRGAWGTAAC
P L E I I A V A X I V A L I X A I V W T I X X I>

5690 5700 5710 5720 pol 136-165 (43) 5750 5760

AGTATTTATTTGCTCAACCAANTCGGAYCCACACTGAATTTCCCTATCTCCCCATTTGASACAGTGCCTGTGAAA
CTATATTTAKAGGAGTGGTTKAGCCTRCGTGTGACTATAAAGGATAGACGGGGTAACTSTGTCACGGACACTTT
E Y V E N X L T O X G X T L N P P I S P I X T V P V K>

A6
join
A7

A7
join
B1

FIGURE 15 (Cont)

SUBSTITUTE SHEET (RULE 26)

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5770 spacers 5800 5810 env 255-284 (153) 5840

CTGAAACCCCGAATGGATGGCGCCGCAAYCTTTAGGCGCTGGCGGAGGCRATATSARAGACAATTGGAGAAGCGAACTGTA
GACTTTGGGCGCTTACCTACCCGCGCGCTGGAATTCGGACCGCTCCGTTATASTYCTGTAACTCTTCGCTTGACAT
L K P G M D C A A X F R P G G G X X X D N W R S E L Y>

5850 5860 5870 5880 5890 5900 5910 5920

TAAGTATAAGGTCGTGRAGATTAGCCTCTGGGARTACATGGATTCCCGAATGGGAGTTCGTCAACACACCCCACTGG
ATTCAATATCCAGCACYTCTAAYTCGGAGACCTYAGTGTACCTAAGGCTTACCTCAAGCAGTTGTGTGGGGGTGACC
X Y K V V X I X P L G X T W I P E W E F V N T P P L>

pol 556-585 (71) 5950 5960 5970 5980 5990 6000

TCAAGCTATGGTATCAGCTGGAGAAAGASCCTATCGYTGGCGTGGAGCTCAGGATCTCAACAYGATGCTGAATAYTGT
AGTTCGATACCATAGTCGACCTCTTCTSGGATAGCRACCGCRACTCGAGTCTAGAGTTGTCTACGACTTATACAT
V X L W Y Q L E K X P I X G X E P Q D L N X M L N X V>

6010 gag 181-210 (13) 6040 6050 6060 6070 6080

GGAGGCCATCAGCGCCCTATGCAAACTGCTGAAAGASACAATCAATGAGGAAGCCGCTCTCTGTTTCTGGATGGCATTRA
CCTCCGGTAGTCCGGGATACGTTTACGACTTTCTSTGTTAGTTACTCTTCGGCGCAGGACAAAGACCTACCGTAAYT
G C H Q A A M Q M L K X T I N E E A A V L P L D G I X>

6090 6100 pol 706-735 (81) 6130 6140 6150 6160

CAAAGCTCAAGAGGAACATGAGARGTATCACTCCAACCTGGAGGACAATGCCARCGAMTTAATCTGTGAAGCATHTCG
GTTTCGAGTTCTCTTGTACTCTYCATAGTACGCTTCACTCTCTGTACCGGTYGCTKAAATTAGACACTCTCGTAKAGC
K A Q E E H E X Y H S N W R T M A X X F N L X K H X>

6170 6180 6190 gag 31-60 (3) 6220 6230 6240

TCTGGGCTCTAGGGAGCTGGAGAGATTGCTCTGAATCCCGCTGCTGGAGACAKCCGAAGGCTGTHAGCAAAATGCT
AGACCCGAGATCCCTCGACCTCTCTAAGCGAGACTTAGGGYCGGACGACTCTGTHGCTTCCGACAKTCGTTTACGA
V W A S R E L E R F A L N P X L L E T X E G C X Q I A>

6250 6260 6270 6280 env 215-244 (151) 6310 6320

GAGGAAGAGATTATCATTAGGTCGAGAAATTCACARACAATGYCAAAACCATTATCGTCCAMCTCAACRAAAGCGTCGW
CTCCTTCTCTAATAGTAAATCCAGCTCTTARAGTGTGTTACRGTTTTGGTAATAGCAGGTRGAGTTGTTTTCCGACGW
E E E I I I R S E N X T X N X K T I I V X L N X S V X>

6330 6340 6350 6360 6370 gag 1-30 (1) 6400

GATTAAATGGGCGCTAGGGCTAGTGTCTCTCAGHGGCGGCRAGCTGGACCCCTGGGAAAAGATTAGGCTCAGGCGCTGGCG
CTAATGTATACCGGATCCCGATCACAGGACTCKCCGCGGCTCGACCTCCGACCTTTTCTAATCCGAGTCCGGACCGC
I N H G A R A S V L X G G X L D A W E K I R L R P G>

6410 6420 6430 6440 6450 nef 91-120 (185) 6480

CAAAGAAAAGTATAGCTCAAGGAGAAGGGAGGCTGGASGGACTGRTTACTCCMAAAGAGGCAAGASATTCTGGAT
CTTCTTTTTCATATCCGAGTTCTCTCTCCCTCGGACCTSCCTGACYAAATGAGGKTTTCTCCGTTCTSTAAGACCTA
G K K K Y R L K E K G G L X G L X Y S X K R Q X I L D>

6490 6500 6510 6520 6530 6540 6550 6560

CTGTGGGTGATACACACAGGGATTCGATGTTGGGGAACCTGATCCTCCGCTGATKATCTGTAGCGCCACCGCA
GACACCCACATATGTGTGCTCCCTAAGCTGACCCCTTGGWACTAGGAGCCGWACCACTAMTAGACATCCGGTCCGCT
L W V Y X T Q G P T R W G T X I L G X V X I C S A S X>

env 16-45 (138) 6590 6600 6610 6620 6630 6640

SAATCTGTGGGTGACAGTGTATTACGGAGTGCCTGTGTGGAGGAGACWGTCTCTGTCCGGCATTGTGCACACAGCAART
STTAGACACCCACTGTACATAAATGCTTACGGACACACCTCTCTGWCAGGACAGCCGTAACACGTTGTCTGTTTAT
N L W V T V Y Y G V P V W R R X L L S G I V Q Q Q X>

6650 env 330-359 (158) 6680 6690 6700 6710 6720

ACCTCTGAGGGCTATCGAAGCCCAACAGCATCTGCTCCAGCTCACCGTCTGCTCAGGCATTTCCTCAGGCGCTTGGCTC
TGGAGGACTCCCGATAGCTTCGGGTGTCTGTAGACGAGGTGAGTGGCAGACCTCAGTCCGTAAGGGGTCCGGAACCGAG
N L L R A I E A Q Q H L L Q L T V W V R H P P R P W L>

B1
join
B2

FIGURE 15 (Cont)

SUBSTITUTE SHEET (RULE 26)

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vpr 31-60 (114) 6750 6760 6770 6780 6790 6800
CACRRCCTGGGACAGYACATCTATGAGACATACGGAGACACATCGMGGGAGTGGAAAGCCCTCAHAGCCCTCATCANACC
GTGYGGACCCCTGTCRTGTAGATACTCTGTATGCCCTCTGTGTACCMKCCCTCACCTTCGGGAGTCTCGGAGTGTCTGG
H X L G Q X I Y E T Y G D T W X G V E A L X A L I X P>

6810 vif 151-180 (110) 6840 6850 6860 6870 6880
CAAAAAGATTARGCCTCCCTCCATCCGTAAGGCTCACCAGACARATGGAATRAGCCTCAAAAGAYTATAGCG
GTTTTCTTAATYCGGAGGGGAGGGTAGGCACCTTTTCGAGTGGCTTCTGTACCTTATTCGGAGTTTTCTTATATACGC
K X I X P P L P S V K K L T E D X W N X P Q K X Y S>

6890 6900 pol 901-930 (94) 6930 6940 6950 6960
CTGGCGAAGGATTTRTCGATATCATTCGACCCGACATTCAGACTAAGGAACTGCAAAASCMAATCHYAAAGATTGAGAAT
GACCGCTTTCTTAAYAGCTATAGTAACGTWGGCTGTAACTCTGATTCCTTGACGTTTTSGITTAGKRTTCTTAAGCTCTTA
A G E R I X D I I A X D I I Q T X E L Q X Q I X K I Q N>

6970 6980 6990 pol 886-915 (93) 7020 7030 7040
TTCCCTGTCTTATCCATAACTTTAAGAGGAAGGGAGGCAATTGCGGGCTACTCCCGCGGAGAGAGAATCRTTGACATTAT
AACCGACACAAATAGGTATTGAAATTCCTTCCCTCCGTAACCGCGATGAGGGGGCTCTCTCTTAGYAACTGTAATA
F A V F I H N F K R K G I G G Y S A G E R I X D I I>

7050 7060 7070 7080 gag 256-285 (18) 7110 7120
CGCCASCGATATCTTCCCGTGGGCGAATCTATAAGAGATGGATCATCTCGGACTCAACAAAATCGTGAGAAATGTATY
CGCGTSGCTATAGYAAAGGGCACCCGCTWAGATATTTCTACCTAGTAAGACCCGAGTGTGTTTAGCACTCTTACATAR
A X D I X P V G X I Y K R W I I L G L N K I V R M Y>

7130 7140 7150 7160 7170 env 495-524 (169) 7200
HACCCGTCAGCATTTCTGGATATGAGAGTGAGACAGGGATACTCCCGCTCAGCTTTCAGACACTGMYGCCCGCTCCAGAG
KTGGCGAGTCTAAGACCTATAGTCTCAGCTCTGTCCCTATGAGGGGGAGTGGAAAGTCTGTGACKRCGGGGCAGGGTCT
X P V S I L D I R V R Q G Y S P L S P Q T L X P A P R>

7210 7220 7230 7240 7250 7260 7270 7280
GGCCCTGACAGACYCGRAGCATTGAGGAAGATTCAGSCAGGACCATCAGTATCCCATTTCCGAACAGCCCTCTGYCTCA
CCGGGAGTGTCTGRCYTCGTAACCTCTCTGAGGTCGTCCTGCTAGTATAGGGTAARGGCTGTGCGGAGACRGAGT
G P D R X X X I E E E S X Q D H Q Y P I X E Q P L X Q>

tal 61-90 (122) 7310 7320 7330 7340 7350 7360
GMCAAGGGGAGRCAATCCACAGRCCCTRAGGAAAGCAAAAGGCACTGCTCGACTCCATGAATAAGGAACTCA
CKGTTCCCTCTYGTAGGGTGTCTGGGATTCCTTTCTGTTTTCCTCACCAGCTCAGTACTATTCTCTGACT
X R G X M P T X P X E S K K A S G V V E S H M K E L>

7370 pol 856-885 (91) 7400 7410 7420 7430 7440
AAAAGATTATCGGACAGGTCAGGGACAGGCTGAGCACCTGAAACCGCTGTGCAATGCTGCGCATGCAGATGCTCAAG
TTTTCTAATAGCTCTGTCAGTCCCTGTCGCACTCTGTGCACTTTTGGCGACAGTTTACGACGGTACGCTACGAGTTT
K K I I G Q V R X Q A E H L K T A V Q M A A M Q H L K>

7450 7460 gag 196-225 (14) 7490 7500 7510 7520
GAWACCATTAAAGGAAGAGGCTGCGGAGTGGGACAGARTCCATCCCGTCCATGCGGACCCRTTSCCCCTTCACCGMGAT
CTWTGCTAATGCTTCTCGGACCGCTCACCTCTGTCTYAGGTAGGGCAGGTACGGCTGGGYAASGGGAGAGTGGCKCTA
X T I N E E A A E W D R X H P V H A G P X X P L T X I>

7530 7540 7550 pol 181-210 (46) 7580 7590 7600
TTGTAMAGAANTGGAAVAAGAGGCAAAATCTCCARGATTGGCCCTGAGAATCCCTATAACACACCCCTCTTTGCCATT
AACATKCTTTTACCTTBTCTTCCGTTTTAGAGGTYCTAACCGGAGCTTTAGGGATATTGTGTGGGYAGAAACGGTAAJG
C X E M E X E G K I S X I G P E N P Y N T P X P A I>

7610 7620 7630 7640 pol 871-900 (92) 7670 7680
AAGTGAGAGASCAGCCGAACACCTCAAGACAGCCGTCAGATGGCAGTCTTCAATCACAATTTCAAAAGGARAGGGCGGA
TTCACCTCTCTSGTTCCGCTGTGGAGTTCTGTCCGCAAGTCTACCGTCAGAAGTAAAGTTTAAAGTTTCTTTCCGCT
Q V R X Q A E R L K T A V Q M A V F I H N F X R X G G>

B2
join
B3

FIGURE 15 (Cont)

SUBSTITUTE SHEET (RULE 26)

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7690 7700 7710 pol 211-240 (48) 7740 7750 7760
ATCGGAGGCAAAAAGATAGCACAAAGTGGAGGAACTGGTAGACTTTAGGGAGCTCAACAAACGTACACAGGATTT
TAGCCTCCCTTTTCTTCTATCGTGTTTCACTCTCTTGACCATCTGAAATCCCTCGAGTGTGTTGCATGTGTCTTAAA
I G G K K K D S T K W R K L V D F R E L N K R T Q D F>

7770 7780 7790 7800 env 540-569 (172) 7830 7840
CTGGGAGGTCCAGCTCGGTTTGGCTCTGGCTTGGGATGACCTCAGGAGCTGTGTCTGTTCACCTATCACAGACTGA
GACCTCCAGGTCCAGCTCGGTTTGGCTCTGGCTTGGGATGACCTCAGGAGCTGTGTCTGTTCACCTATCACAGACTGA
W E V Q L G F X A L A W D D L R S L C L F S Y H R L>

7850 7860 7870 7880 7890 vpr 76-96 (117) 7920
GAGACTTATCTCATCGYTCGCCAAATTCCTACATAGCAGAAATCGGCATCACTAGGCAACGTAGAGSTAGGAACGGC
CTCTGRAATAGGAGTAGCRACGCTCTTTCACGGYTCATCGCTTAGCCGTAGTGATCCGTTCGATCTC SATCCCTGCGG
R D X I L I X A R X C X H S R I G I T R Q R R X R N G>

spacers 7950 7960 7970 env 155-184 (147) 8000
KCCTCCAGGTCTGCTGCCCAAAATTCCTTCGAGCCATTCCCACTTATGCGCTCCCGCTGGCTTCGCTATCTCT
MGGAGGTCCAGCTCGACGGGGTTTATGAGGGAAGCTTGGGTAAGGGAAGTATGATAACCGAGGGGACCCGAGCCATAGCA
X S R S A A P K X X F X P I P I H Y C A P A G X A I L>

8010 8020 8030 8040 8050 vif 76-105 (105) 8080
CAAGTGTACRATAAGAAATTCATGCTCAAAGGATTGGCAWCTGGGACASGGAGTGTCCATCGAATGGAGAAAGAAA
GTTTCACATTCGTATCTTAAAGTTACCTCTTTCCTAACCGTTCGACCTGTCTCTCACAGGTAGCTTACCTCTTCTTT
K C N X K K F N G E X D W X L G X G V S I E W R X K>

8090 8100 8110 8120 8130 gag 481-499 (33) 8160
GSTATAGCACAGGTGGACCTGRCCTCGCCGATCACTCTCTATCTCTCTTACCTTCCCTGAAAAGCCTCTTC
CSATATCGTGTGTCACCTGGGACGAGCGGCTAGTCTGAGATAGGACCGGARTCGAAGGGACTTTTCGGAGAAG
X Y S T Q V D P X L A D Q P S L Y P P X A S L K S L F>

8170 spacers 8200 8210 vif 121-150 (108) 8240
GGAAACGATCCCTTATCCCAAGCCGCTGAAGAGGCTATCTCTCGCCANAAAGTCAAGSAGAAAGGTGTGAGTATGKCCGG
CCTTTGCTAGGGARTAGGTTTCGGGATCTTCCCGATAGGAGCCGGTWTTCAGTCTCTCTCCCACTCATAGKACGCC
G N D P X S Q A A R R A I L G X X V X R R C E Y X X G>

8250 8260 8270 8280 8290 8300 8310 8320
ACACAATAGGTGCGCTCCCTGCAATACCTCGCACTAGCCAAACCCAAACCGCTTGCWCAAGTGTACTGTAAAGAAAT
TGTGTTATTTCCAGCCGAGGACGTTATGACCGCTGATTCGGTGGGTCTTGGCGAACGKGTTCACAATGACATCTTTA
H M K V G S L Q Y L A L S Q P X T A C X K C Y C K K>

tat 16-45 (119) 8350 8360 8370 pol 976-995 (99) 8400
GTTGCTMCACTGTCAAGSTCTGCTTCTCGAAGAGGACTGGGAATAGGGATTACGGAAAGCAATGGCTGGCGHTCAG
CAACGAGGTTGACAGTCSAGACGAAGGACTTCTTCCCTGACCCCTTACTCTTAAATGCTTTCGTTTACCGACCGCACTG
C C X H C Q X C F L X K G L G I R D Y C K Q M A G X D>

8410 spacers 8440 8450 pol 721-750 (82) 8480
TGTTGCGCCRCAGGCAAGACGAAGAGCGAGCAAGTACCATAGCAATGGAGAACCATGGCCARTGASTTTAACCTCCC
ACACACCGGTCGCTCGCTTCTGCTTCTCGTCCGTTTATGATCGTTAACCTCTTCTGACCGCTTACTSAAATGGAGGG
C V A X R Q D E D A A K Y H S N W R T M A X X F M L P>

8490 8500 8510 8520 8530 8540 8550 8560
CCCTATCGTCSCTAAGGAAATCGTGGCAWRTTGGGATAAGTGTACCAATGGRCACCTGGAACTGCTGGAGGAAGTGAAM
GGGATAGCAGSGATTCTTTAGACCGGTWYAACGCTATTACATTCGCTTACCTGTGACCTTGACGACCTCTTACTTTK
P I V X K E I V A X C D K C N E W X L E L L E L K>

vpr 16-45 (113) 8590 8600 8610 8620 8630 8640
ANGAAGCCGTGAGACACTTTCCAGACCTGGCTGCATGGCTCGGTCAACAGCATRTCAATAGCCTCTGGGATCAGTCC
TWCTTGGCACTCTGTGAAGGGTCTGGGACCGAGCTACCGGAGCCAGTTGTCTAYAGTAATCGGAGACCTAGTCAGG
X E A V R H P P R P W L H G L G Q H D X I S L W D Q S>

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FIGURE 15 (Cont)

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8650 env 106-144 (144) 8680 8690 8700 8710 8720
CTGAAACCCCTGTGTGAACTGACACCCCTGTGGCTACCCCTCAACTGTACCAATGCCAATCTGMAAGAGHTACTCCAC
GACTTTGGGACACACTTTGACTGTGGGAGAGCGAGTGGGAGTTGACATGGTTACGGTTAGACATCTCTCTCKATGAGGTG
L X P C V K L T P L C V T L N C T N A N L X K X Y S T>

8730 8740 vif 91-120 (106) 8770 8780 8790 8800
CCAAGTGGACCCCGTCTGGCTCAACACTGATTCACCTCCACTATTTGGATTGCTTTKCCGATAGCRAATTCATCCCA
GGTTCACTTGGGCGYAGACCGACTGGTGWACTAACTGCAGGTGATAAAGCTAAACGAAAHGGCTATCGYGTAGTAGGGT
Q V D P X L A D X L I H L N Y F D C P X D S X I H P>

8810 8820 8830 nef 166-195 (190) 8860 8870 8880
TSRGCCWACACGGAATGGAGGATGAGGAMAGGGAAGTCTGAWATGGAAATTCGATAGCCRTCTGGCTCKACGCCATATS
ASYCGGTGTGCTTACCTCCTACTCTTWCCTTCACGACTWTACCTTTAAGCTATCGYAGACCGAGMGTCCGTATAS
X X X H G M E D E X R E V L X W K P D S X L A X R H X>

8890 8900 8910 8920 pol 151-180 (44) 8950 8960
GCTATCGAWACCGTCCCGTCAAGCTCAAGCCTGGCATGGACGGACCCAAAGTGAACAGTGGCCCTCAC
CGATAGCTWTGCGAGGGCAGTTCCAGTTCGGACCGTACCTGCGTGGTTTCACTTTGTACCCGGGAGTG
A S S P I X T V P V K L X P G M D C P K V K Q W P L T>

8970 8980 8990 9000 9010 gag 436-465 (30) 9040
CGAAGAGAAATCAAAGCCTTTGGCTAGCMRCAAGGGAAGCCCTGGCAATTTCCYGCAGTCCARGCCTGAGCCTACCG
GCTTCTCTTTTAGTTTCGTAAACCGGATCGYGTTCCTTCCGACCGTTAAAGGRCGTAGGTYCGGACTCGGATGCC
E E K I K A I W P S X K G R P G N P X Q S X P E P T>

9050 9060 9070 9080 9090 vif 31-60 (102) 9120
CACCCCCAGCCGAGARCTTTTGATTGGGATTAGCAAAAAGGCTAASGGATGGTTTACAGACACCATTWCGANAGCCRA
GTGGGGGTCGGCTCTYGAAYCTAAGCCCTAATCGTTTTCGATTSCCTACCAAAATGCTGTGGTAANGCTWTCCGYT
A P P A E X P X F G I S K K A X G W P Y R H H X X S X>

9130 9140 9150 9160 9170 9180 9190 9200
CACCTAAGGTCAGCTCCGAGGTCACATTCCCTCGGATGATGACCGCTTCCCAAGGCGTCCGCGACCCRCGTACAA
GTGGATTCCACTCCAGGCTCCAGGTGTAAGGGGACCCCTACTACTGGCGAAGCGTTCCGACGCGCTGGGYCAGTGT
H P K V S S E V H I P L G M M T A C Q G V G C P X H K>

9230 9240 9250 9260 9270 9280 gag 346-375 (24)
AGCCAGGGTACTGGCAGAGGCTATGTCAGGTYGAMCHACGCTAACATTCCTCCCATTTGTGSCCAAAGAGATTGTGGCAN
TCGGTCCCATGACCGTCTCCGATACAGGCTCCRTGKTTGGATTGTATAGGAGGTAACACSGGTTTCTTAACACCGTW
A R V L A E A M S Q X X X A N I P P I V X K E I V A>

9290 9320 9330 9340 9350 9360 pol 736-765 (83)
RCTGTGACAAATGCCAGCTCAAGGGTGAGGCTATKACGGACAGGTGACTGTAGCCCTTCCGAGGGAWCAAGACAGRCT
YGACACTGTTTACGGTGGAGTTCCCACTCCGATAGTGCCTGTCCACYTGACATCCGGTACCGCTCCCTWCTTCTCTCYGA
X C D K C Q L K G E A X H G Q V X C S P S E G X R Q X>

9370 9380 rev 31-60 (126) 9410 9420 9430 9440
AGGARGAACAGACGTAGAAGGTGGCGTGMGAGGCAAGGCAAAATCCRCXCATCTCCGAGWGGATTCTGGACAGATRAG
TCCTTCTGTCTGCTATCTTCCACCGCACCTCCGTTTCCGTTTACGGYGMGTAGAGGCTCWCCTAAGACCTGTCTAYTC
R I N R R R R W R X R Q R Q I X X I S E X I L G Q X R>

9450 9460 9470 gag 226-255 (16) 9500 9510 9520
GGAAACCAAGGCTCCGACATTGCGGTACCAAGCACACTCCAAGAGCAAAATCGSATGCGATGACAARCAATCCCCCTR
CCTTGGGTCTCCGAGGCTGTAACGCCATGGTGTGCTGACGTTCTCGTTTACGCTACCTACTGTTTGTAGGGGAY
E P R G S D I A G T T S T L Q E Q I X W M T X N P P>

9530 9540 9550 9560 pol 841-870 (90) 9590 9600
RCATTAGCAAGAGTTTGGCATTCCCTATAACCTCAGTCCAGGGCGCTGTGGAAGCATGAACAAAGAGCTCAAGAAA
YCTAAKTCGTTCTCAAAACGTAAGGATATTGGAGTCAAGGTCCTCCGACGACCTTTCGTACTTCTTCTCGAGTTCTTT
X I X Q E P G I P Y N P Q S Q C V V E S M N K E L K K>

B4
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B5

FIGURE 15 (Cont)

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**B6
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B7**

FIGURE 15 (Cont)
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env 585-614 (175) 10590 10600 10610 10620 10630 10640
CNGTACTGGGGCCWGGAACTGAAAMCTCCGCCRTCAGCCTCCTGAATGCCACAGCATTSMGCTGCCCTGAGAAAGANAG
GMCATGACCCCGGNCCTTGACTTTTWAGGGCGGYAGTCGGAGGACTTACGGTCTCCCTAASWCGACCGACTCTTCTWTCT
X Y W G X E L K X S A X S L L N A T A I X L P E K X S>

10650 pol 391-420 (60) 10680 10690 10700 10710 10720
CTGGACCGTCAACCATATCCAAAAGCTCGTGGGAAAGCTCAACTGGCATCCAGATTACSCCGGAGAGCCATTGAGG
GACCTGGCAGTTGCTATAGCTTTTCGAGCACCCCTTTTCGAGTTGACCCGTAGGGTCTAAATGSGGCCCTCTCGGTAACCTCC
W T V N D I Q K L V G K L W M A S Q I Y X G R A I E>

10730 10740 env 345-374 (159) 10770 10780 10790 10800
CTCAGCAACACWTCCTGCAACTGACAGTGTGGGGCATTAAAGCAACTGCAAGCCAGAGTGTCCGCRITGAGAGATGCTC
GACTCGTTCTGACGACGTTGACTGTACACCCCGTAATTCGTTGACGTTCCGTTCTACGAGCGGYAACTCTCTATGAG
A Q Q H X L Q L T V W G I K Q L Q A R V L A X E R Y L>

10810 10820 10830 pol 631-660 (76) 10860 10870 10880
GCCCTCCAGGATAGCGGATYGGAAAGTGAATATCGTCACCGATAGCCAAACGCTCTAGGCATCATTWGGCTCAGCCTGA
CGGAGGTCCTATCCGCTARCCCTTCACTTATAGCAGTGGCTATCGCTTATGCGAGATCCGTAGTAAGWCCGAGTCCGACT
A L Q D S G X E V N I V T D S Q Y A L G I I X A Q P D>

10890 10900 10910 10920 env 420-449 (164) 10950 10960
CARAAGCGAAAGGGAAATCTCCAACTATACCACTCWGATTACRAGATCCTCACCAGAACTCAAAATCAACAGGATAGGA
GTYTTCCTTTCCCTTTAGAGTTGATATGGTYAGWCTAAATGYTCTAGGAGTCCCTTAGACTTTTAGTCTCTCTATCTCT
X S E R E I S N Y T X X I Y X I L T E S Q N Q Q D R>

10970 10980 10990 11000 11010 env 285-314 (155) 11040
ATGAGMAAGACTCCTGCTCCCAARGGCTAAGAGAAGGCTCGTGSAAAGGGAAAGCGTGCCGCTCGGCTTTCGGCT
TACTCTCTCTGAGGACGAGGGCTTTCGATTTCTCTCCAGCACSTTCCCTTTTCGACGGCAGCCGCAACCCGGA
M E X X L L A P T X A K R R V V X R E K R A V G X G A>

11050 11060 11070 11080 11090 pol 91-120 (40) 11120
ATGWTTCCTGGATTCCTCGGCGCTGCCAAACCCAAATGATCCGACCGATTGGAGGCTTTATCAAGTCAGGCACTATGA
TACMAARAGCCTAAGGAGCCCGCACCTTTTCGCTTTTACTAGCTCCGTAACCTCCGAAATAGTTTCAGTCCGCTACT
M X X G F L G A A K P K M I G G I G G F I K V R Q Y D>

11130 11140 11150 11160 11170 11180 11190 11200
CCAAATCTTATCGAAATCTGTGGMAASAGGCTATCTCTACCAATAGGCTCAGGGATTTCATTCGATCGYCGCTAGGA
GGTTTAGKAATAGCTTTAGACACTTSTTCCGATAGAGGATGGTATCCGAGTCCCTAAAGTAAGACTAGCCGCACTCT
Q I X I E I C G X K A I S Y H R L R D P I L I X A R>

env 555-584 (173) 11230 11240 11250 11260 11270 11280
YTGTGGAATGCTCGGCCRTAGCTCCCTGARAGGCTCCRGAGAGGACACTGAATGCCCTGGGTGAAAGTGRTTGAGGAA
RACACTTGACGAGCCGGYATCCAGCGACTTTCGGAGGYCTCTCCCTGTGACTTACGGACCCACTTTCACYAACCTCTT
X V E L L C X S S L X G L X R G T L N A W V K V X E E>

11290 gag 151-180 (11) 11320 11330 11340 11350 11360
AAGGSATTCARTCCCGAAGTGATTCCTATGTTTCCGCTCTCTCGGAGGAGCCACAGCAACACASCCGCTAA
TTCCSTAGTYAGGCTTCACTAAGGCTACAAANGGCGAGACAGGCTCCCTCGGTGTAAGTTCGTTGTGTSGGCGATT
K X F X P E V I P M F X A L S E G A T L E S N T X A N>

11370 11380 nef 46-75 (182) 11410 11420 11430 11440
CAATSCCGATTCCGYCTGCTGTAAGCCCAAGGAGGAAGRAGTGGGATTTCCTGTGAGACCCCAAGTCCCTAGAGCCCK
GTTASGGCTAAGCCRCACCGACTTTCGGGTCTCTCTCTCTCTACCCCTAAAGGACACTCTGGGGTTCACGGATCTCGGH
N X D C X W L X A Q E E X V G F P V R P Q V P R A>

11450 env 630-651 (178) 11480 11490 spacers 11520
GGAGGGCTATCCTCHACATTCCASGAGGATTAGCCAAGGCTTGTGAGAGAGCCCTCTAGCCGCGAATGGGATAGGRTT
CCTCCGATAGGAGRTGTAAAGGTSCTCTAATCCGTTCGGAACCTCTCTCGGAGGATCGGCGCTTACCTATCCYAA
X R A I L X I P X R I R Q G X E R A L L A A E W D R X>

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FIGURE 15 (Cont)

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11530 11540 gag 211-240 (15) 11570 11580 11590 11600
CACCTGTGCACGCTGGCCCTRTCTCTCCCGGCCAAATSAGAGAGCCCGAGGGAAGCGATATCGCTGGCACAACCTCAG
GTGGGACACGTGGACCGGGAYAGSGAGGCGCGCTTASTCTCTCGGGTCCCTTCGCTATAGCGACCGTGTTCGAGTC
H P V H A G P X X P G Q X R E P R G S D I A G T T L R>

11610 11620 11630 nef 76-105 (184) 11660 11670 11680
GCCCCATGACATATAAGGSCGCTRTTGACCTCAGCTGTGTTCTGAAAGAGAAAGGCGGACTGGAMGGCCTCTCTATAGCM
CGGGTACTGTATATTCSSCGGAYAACTGGAGTCGRACAAAGACTTTCTCTTCCGCTCAGCTWCCGGAGYAGATATCGK
P M T Y K X A X D L S L F L K E K G G L X G L X Y S>

11710 11720 vpr 1-30 (112) 11750 11760
spacers
AGAAAGCTGCTATGGAACAGGCTCCCGAAGACCAARGCYCTCAGAGAGAGCCTTACAATGAGTGGRCCTCGGAGCTCCTG
TCTTTCGACGATACCTTGTCCGAGGCGCTTCTGGTTYCGRGAGTCTCTCTCGGAATCTTACTCACCYGGGACCTCGAGGAC
X K A A M E Q A P E D Q X X Q R E P Y N E W X L E L L>

11770 11780 11790 11800 11810 pol 481-510 (66) 11840
GAAGAGCTCAAGHAMAGGCTCAAGRCCAATGGACCTWCCAAATCTWTCAGGAACCTTTAAGAATCTGAAAACCGGAAA
CTTCTCGAGTCTCTCTCGGAGTTCYGGTTACCTGGAWGGTTAGAWAGTCTTGGGAAATCTTAGACTTTTGGCCTTT
E E L K X X E A Q X Q W T X Q I X Q E P F K N L K T G K>

11850 11860 11870 11880 11890 11900 11910 11920
GTATKCCAGAAMGAGARGCCTCACACAAATGGATGACAGAAACCTCTGGTCCAGAATGCCAATCCCGATTGCCAAGW
CATAMGGTCTTCTCTYCGGAGTGTCTTACCTACTGTCTWTTGGGAGGACCAGGTCTTACGGTTAGGGCTAACGTTCTW
Y X R X R X A H T N W M T X T L L V Q N A N P D C K>

11950 11960 11970 11980 11990 12000
gag 316-345 (22)
CCATCTCTCARGGCTCTGGGAMCCGAGCCWCACTGGAGAGACCTGAGGTATCCCTATGTTTCWAGCCCTCAGCGAAGGC
GGTAGGAGTCTCGGACCCCTGGGCTCGGAGTGCCTTCTGGACTCCAGTAGGGATACAAGTCTCGGAGTCTCGCTCCG
X I L X A L G X G A X L E E P E V I P M F X A L S E G>

12010 12040 12050 12060 12070 12080
gag 166-195 (12)
GCTACCCCCAAGACCTGAATAYGATGCTCAACAYCGTGGCGGACACCAATCCACCTCCAGGAACAGATTGCTGGAT
CGATGGGGGCTTCTGGACTTATCTACGAGTGTGTCAGCCGCTGTGCTTAGGTGGAGGTCTTGTCTAACSGACCTA
A T P Q D L N X M L N X V G G H Q S T L Q E Q I X W M>

12090 12100 gag 241-270 (17) 12130 12140 12150 12160
GACAARTAACCTCCCTCTCTCGGAGASATTTACAAAAGGTGGATTATCTCTCGGCTCTATCCCCATCCCG
CTGTTTATGGGAGGGYAGGCACAGCCTCTSTAAATGTTTCCACCTAATAGGAGCCGMAATAGGGGGTAGGGC
T X N P P X P V G X I Y K R W I I L G L T R I P H P>

12170 12180 12190 pol 241-270 (50) 12220 12230 12240
CCGGCCTCAAGAAAAAGAAAGCGTCACCGTCTGGATGTGGGAGACGCTTACTTCAGCGTCCCCCTCGACRAARRCAA
GGCCGGAGTCTTTTCTTTTCGAGTGGCAGGACCTACACCTCTGCGAATGAAGTCCGAGGGGAGCTGYTTYGGTT
A G L K K K K S V T V L D V G D A Y P S V P L D X X Q>

12250 12260 12270 12280 pol 541-570 (70) 12310 12320
ARGGAAACCTGGGAGRCTTGGTGGAYGGAMTACTGGCAGGCTACCTGGATTCTGAGTGGGAGTTGTGAATACCCCTCC
TYCCTTTGGACCTCYGAACCACTTRCTATGACCGTCCGATGGACCTAAGGACTCACCTCAAACACTTATGGGGAGG
X E T W E X W W X X Y W Q A T W I P E W E P V N T P P>

12330 12340 12350 12360 12370 nef 121-150 (187) 12400
CCTCGTCTTCCCGATTGGCANAATATACCCCTGGCCCTGGCRYAAGGTATCCCTCACCTTTGGATGGTGCTTTAAGC
GGAGCAAAAGGCTAACCGTTTGATATGGGACCGGACCGGYRTTCCATAGGGGAGTGGAAACCTACCACGAAATTCG
L V P P D W X N Y T P G P G X R Y P L T P G W C F K>

12410 12420 12430 12440 12450 pol 571-600 (72) 12480
TCGTGCTGTGGACCCCAACTGTGTGTTACCAACTGGAAGGAMCCATTGYCGAGYCGAAACCTTTTACGTGGACGGA
AGCACGGACACCTGGGTTTGACACCATGGTTGACCTTTCTTGGGTAAACRGCTCTGCTTTGGAAATGCACCTGGCT
L V P V D P K L W Y Q L E K X P I X G X E T F Y V D G>

FIGURE 15 (Cont)

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12490 12500 12510 12520 gag 136-165 (10) 12550 12560
CCCCCCARCAGAGAGACAAAGCTCGGC AAAACSYCCAGGACAGATGGTGCATCAGSCTMTTAGCCCCAGGACCCCTCAA
CGCGCGGTGTCTCTCTGTTTCGAGCCGTTTTSRGGTCCCTGTCTACCACTAGTCSGAKAATCGGGTCTCTGGAGTT
A A X R E T K L G Q N X Q G Q M V H Q X X S P R T L N>

12570 12580 12590 12600 12610 env 61-90 (141) 12640
CGCTTCGCTCAAGCTCTCTGAGAGAAAGSCTTTARCGAHACCGAAGTGCAATACGCTCTGGGTACCCATCGCTGTGTGC
CGGAACCCAGTTCCAGYAGCTTCTCTTSCGAAATYCTKTGCTTCACGTATTGCAGACCCGATCGGTACGGACACACG
A W V K V X E E K X F X X T E V H N V W A T H A C V>

12650 12660 12670 12680 12690 12700 12710 12720
CTACCGATCCCAATCCCAAGAGRTTSWCCTGGAGAATGTGACAGACTCAAGGATCAGMAAYTCTCGGCMTTTGGGGA
GATGGCTAGGGTTAGGGTTCTCYAASWGGACCTCTTACACTGTCTGAGTTCTTAGTCTTTRAGGAGCCGKAAACCCCT
P T D P N P Q E X X L E N V T E L K D Q X X L G X W G>

env 375-404 (161) 12750 12760 12770 12780 12790 12800
TGCTCCGGCAAAHTCATTTGCACAAACCRMTGTGCTTGGAAACAGCWCCTGGTCCAACTMAKCTGGCCATAACAAAGTGGG
ACGAGGCCGTTTTRAGTAACCTGTTCGYKACACGGAACTTGTGCGGGACACAGTTGKTHGACCGGTATTGTTTCACCC
C S G K X I C T T X V P W N S X W S N X X G H N K V G>

12810 vif 136-165 (109) 12840 12850 12860 12870 12880
AAGCCTCCAGTATCTGGCTCTGAGGGCTCTGATTAGCCCTAAGAAAATCARACCCCTCTGCTTAGCTTAAGACAATCA
TTCCGAGGTCATAGACCGAGACTTCCGAGACTAATKCGGATCTTTAGTGTGGGGGAGACGGATTCRATTCTGTGTAGT
S L Q Y L A L X A L I X P K K I X P P L P S X K T I>

12890 12900 env 230-254 (152) 12930 spacers 12960
TTGTGCATCTGAATRAGTCCGTGGWAATCAATTGACAAAGCCCTARCAATAACACAAAGCAAGCCGCTCAAGNA
AACACGTAGACTTAYTCAGGCACCTTATGTAACTGTTCGGATYGTATTGTGTCTCTKCGGCGCTCTTCWT
I V H L N X S V X I N C T R P X N N T R X A A A S E X>

12970 12980 12990 gag 106-135 (8) 13020 13030 13040
CAGAAHAACTCCAAACAGAAAACCCAGCAAGCCCGCCGCTATACAGGCARCTCCAGCAAGGTACAGCCAAAATATCCCAT
CTCTTTTTCAGGTTGTCTTTTCGGCTCTTCGGCGCGCGCTATGTCCGTGAGGTCGTCCTCAGTCGGTTTGTATAGGGTA
Q X K S X Q R T Q Q A A A D T G X S S X V S Q N Y P I>

13050 13060 13070 13080 pol 826-855 (89) 13110 13120
TGTTTCCAACCTTACCTCCRCRCTGTGAAGCCGCTTGTGTTGGGCGRRATATCAACAGGAGTTTGAATCCCTTACA
ACACAGGTTGAAATGGAGGYGGYACACTTTCGCGCAACAAACCCGGYATAGTGTCTCTCAAACTTAGGGAAATGT
V S M P T S X X V K A A C W W A X I X Q E F G I P Y>

13130 13140 13150 13160 13170 pol 586-615 (73) 13200
ATCCCCAAAGCCAAACATTCTATGTGGATGGCGCTGCCARTAGGGAACCAAACTGGGAAAGGCTGGCTATGTGACAGAC
TAGGGGTTTCGGTTGTAAAGATACACCTACCCGACGGYATCCCTTTGGTTGACCTTTCCGACCGGATACACTGTCTG
N P Q S Q T P Y V D G A A X R E T K L G X A G Y V T D>

13210 13220 13230 13240 13250 pol 766-795 (85) 13280
AGAGGCAGACAGAAARTCRTTAGCGAATCTGGCAGCTCGACTGTACCCATCTCGAAGGCAAAARTATTCTGGTAGCCGT
TCTCCGTCTCTCTTAYAGYAATCCCTTAGACCGTCGAGCTGACATCGGTAGACCTTCCGTTTAYTAAGACCATCGGCA
R G R Q K X X S G I W Q L D C T H L E G K X I L V A V>

13290 13300 13310 13320 13330 13340 13350 13360
CCACGTCGCCCTCCGGCTACATTGAGGCTGAGGTGGCAATGACCAAGTGATAAGCTCGTGARTKCCGGAATCAGAAAGG
GGTGACGGGAGCGGATGTAATCCGACTCCACCGTTACTCGTTACCTATTGAGCACTHAGGCCCTTAGTCTTTCC
H V A S G Y I E A E V G N E Q V D K L V X X G I R K>

pol 691-720 (80) 13390 13400 13410 13420 13430 13440
TGCTATCTCTCGACGGAAATCRATAAGCCTCAGGAAGACACGAGTCAAGGAAAGGATTAGGCRARCCSCTCCCGTCT
ACGATAAGGAGCTCCCTTACGTATTCAGGCTCTTCTCTGCTCTCAGTCCCTTTCCTAATCCGYTYGSGAGGGCGACGA
V L F L D G I X K A Q E E H E V R E R I R X X X P A A>

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C3FIGURE 15 (Cont)
SUBSTITUTE SHEET (RULE 26)

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nef 16-45 (180) 13470 13480 13490 13500 13510 13520
GAAGGCGTCGGCGCTGYCTCCCRGGATCTGGATAAGKACGGAGCCMTACCTCCACAAGCGGAACCCACAGTCCCAGGG
CTTCCGCGACCGCGACRGAGGGYCTTAGACCTATTCTGCTCGGKAGTGGAGTGTTCGCTTGGGTTGTTCAGCGTCCC
E G V G A X S X D L D K X G A X T S T S G T Q Q S Q G>

13530 rev 91-120 (130) 13560 13570 13580 13590 13600
AACTGAAACTGGCCTCGGCHRCCTCAGATTTTGGCAGACTCCAGCGTTCCTCGGCTCGGCTCCATCGTCATCTGGG
TTGACTTTGACCCGACCGKYGGGAGTCTAAARCCCTCTCAGGTCGCRA YAGGAGCCGCGGCCAGCTAGCAGTAGACCC
T B T G V G X P Q I X G E S S X X L G X G S I V I W>

13610 13620 pol 526-555 (69) 13650 13660 spacers
CTAAAACCCCTAAGTTTARGCTCCCATTCAGARAGAGACATGGGAARCTCGGTGGAYGGASTATTGGCAAGCCGCTGCT
CATTTTGGGGATTCAAATTCGAGGGGTAAGTCTTCTGTACCTTTCGACCCACCTTCCTCTATACCGTTTCGGCGACGA
G K T P K F X L P I Q X E T W E X W W X X Y W Q A A A>

13690 13700 13710 env 140-169 (146) 13740 13750 13760
TACAGACTGATCARCTGTAAACACAAGCGYTATCAHACAGGCTTGGCCCTAAGRTTASCTTTGASCCCTATCCCTATCCATTA
ATGTCTGACTAGTYGACATTGTGTTCCCRATAGTGTCTCCGAACCGGATTCTAATSGAAACTSGCATAGGCGATAGCTAAT
Y R L I X C M T S X I X Q A C P K X X F X P I P I H Y>

13770 13780 13790 13800 pol 376-405 (59) 13830 13840
CTGTGCCCCCTGGATGGGCTATGAGCTCCACCTTGACAGATGCAACCCATC SWGCTCCCCGAAAAGG
GACACGGCGGACCTACCTGTAAGTCTTTGTTAAGACTTTCGGGAGCCGKGTCCCGGAGGGGACCTCTTTACTACTGT
C A P P S W M G Y E L H P D R W T V Q P I X L P E K>

13850 13860 13870 13880 13890 gag 331-360 (23) 13920
ASTCCTGCAGACTGAATGACATTCAGAAANCAATCTGARAGCCCTCGGCHCAGGCGCTWCCCTGGAGGAAATGATGACA
TSAGGACCTGTCACTTACTGTAAGTCTTTGTTAAGACTTTCGGGAGCCGKGTCCCGGAGGGGACCTCTTTACTACTGT
X S W T V W D I Q K X I L X A L G X G A X L E B M M T>

13930 13940 13950 13960 13970 13980 13990 14000
GCATGTCAAGGAGTGGGAGGCGCTTCGCCATAAGGCTAGAGTGTATTACAGAGACTCCAGGCAACCCMTTGGAAAGGCGCC
CGTACAGTCCCTACCCCTCCCGGAYCGGTATTCCGATCTCACATAATGCTCTCAGCTCCCTCGGCGAAACCTTTCCGGG
A C Q G V C G P X H K A R V Y Y R D S R D P X W K G P>

pol 931-960 (96) 14030 14040 14050 14060 14070 14080
TGCCAAACTGCTTCGGAAGCGGAAGGCGCTGTGCTATCCAAAGATTTAAGATTGGAGGCCAACTGAWAGAAGCCCTCC
ACGGTTTGACGAGACCTTTCCGCTTCCCGGACACCACTAGGTTCTCTAATTCTAACCCTCGGTTGACTTWTCTTCGGGAGG
A K L L W K G E G A V V I Q D X K I G G Q L X E A L>

14090 pol 61-90 (38) 14120 14130 14140 14150 14160
TGATACAGGAGCCGATGACACCGTCTCGAAGAWATSAATCTGCTCGCARGTGGCAATCAACAGCTCCAGGCTAGG
ACCTATGTCTCGGCTACTGTCCGAGACCTTCTMTASTTACAGGACCGTTCACCTCTAGTTTTCGAGGTCCGATCC
L D T G A D D T V L E X X N L P G X W G I K Q L Q A R>

14170 14180 env 360-389 (160) 14210 14220 spacers
GTCCTGGCTRTCCAGAGGTATCTGAAGATCAAMAGYTTCTCGGAMTCTGGGCTAGCGGAAACGCTGCTATGGAAA
CAGGACCGAYAGCTCTCCATAGACTTTCTAGTTRTCRAAGACCCCTAGACCCCGACATCGCTTTCCGACGTACCTTTT
V L A X E R Y L K D Q X X L G X W G C S G K A A M E N>

14250 14260 14270 vif 1-30 (100) 14300 14310 14320
CAGATGGCAAGTGTGATCGTCTCGCAACTGACAGGATGARGATTAGGACATGGAAWAGCCCTGTGAACACCATATGY
GTCTACCGTTTCACTAGCAGACCGTTACCTGTCTACTYCTAATCCTGTACCTTWTCCGAGCACTTTGTGGTATACR
R W Q V X I V W Q V D R M X I R T W X S L V K H H M>

14330 14340 14350 14360 env 390-419 (162) 14390 14400
ATTTATCTGTACCACARHCGTCCCTCGCAACTCCASCTGGAGCAATAAGTCCYTCCGAAGAGATTGGRATAACATGACC
TAKAATAGACATGGTGTGKCGAGGGACCTTGAGTSCACCTCGTTATTCAGGRAGCTTCTCAAACCTATTGTACTGG
X X I C T T X V P W N S X W S N K S X E B I W X N M T>

C3
join
C4FIGURE 15 (Cont)
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14410 14420 14430 vpu 16-45 (133) 14460 14470 14480
TGGATKSAATGCTGATTTCGGCTATCGTCGTGGACCATGTYGTWTATCGAATACARGAACTGCTCARGCAAAGGAR
ACCTAMSTTACCGACTAAKAGCGATAGCAGCACACCTGGTAACRCAMATAGCTTATGTYCTTTGACGAGTYCGTTTCCTY
W X X W L I X A I V W T I X X I E Y X K L L X Q R X>

14490 14500 14510 14520 gag 46-75 (4) 14550 14560
AATCGATAGGCTCATCRAAGGCTCAACCCCTGGCTCTCGGAAACCKCTGAGCGATGTHAACAGATCCTGGRACAGCTCC
TTAGCTATCCGAGTAGTTTTCGAGTTGGGACCGGAGCACCTTTGCGCACTCCCTACAKTTGCTTAGGACCTTGTGAGG
I D R L I X R L N P G L L E T X E G C X Q I L X Q L>

14570 14580 14590 14600 14610 14620 14630 14640
AGYCCGCCCTCMAGACAGGCMCCGAAGAGCTTCTGAGAAAGCTCCTGARACAGAGAARGATTGACAGACTGATTTRAG
TCRGGCGGGAGRTCTGTCCGCGCTTCTCGAGCTCTCTTCGAGGACTTGTCTCTTYCTAACTGCTGACTAAATC
Q X A L X T G X E E L S S R K L L X Q R X I D R L I X>

vpu 31-60 (134) 14670 14680 14690 14700 14710 14720
AGAAACAGAGAGAGGCGAAGACTCCCGCAATGACTCCGAGGGAGACACCCGGAATCAGATACCAATACAATGTGCT
TCTTRGTCTCTCTCGGCTTCTGAGCCGCTTACTCAGGCTCCCTCTGTGTGGGCTTAGTCTATGTTATGTTACACGA
R X R E R A E D S G N E S E G D T P G I R Y Q Y N V L>

14730 pol 286-315 (53) 14760 14770 14780 14790 14800
CCCCCAAGGCTGGAAGGCTCCCCASCCATTTTCCAAGCTCCATGACCAAAATCCTATGATGCAAGGGGAACTTTA
GGGGGTTCCGACCTTCCGAGGGTSGGTAAAGCTTTCGAGGTACCKGKTTAGGAGTACTACGTTTCCCTTTGAAAT
P Q G M K G S P X I P Q S S M X X I L M M Q R G N F>

14810 14820 gag 376-405 (26) 14850 14860 14870 14880
RGGGACMGAAAGGATTTCAGTGTCTCAACTGTGGAAAGGAAGCCATHTCGCTARGAATTCAGACTCTCCCTCGGAG
YCCCTGKCTTTTCTTAAYAGTTACGAAGTTGACACCTTTCTCTCCGTAAGCGATYCTTAACGCTCTGGAGGGGACCTC
X G X K R I X K C F N C G K E G H X A X N C R P P L E>

14890 14900 14910 rev 76-105 (129) 14940 14950 14960
AGACTGMACTCGATTCTCCGAGGATMGCGRCACCTCCCGCACACAGCAAGCCAAAGCCACAGAGACAGGAGTGGGACT
TCTGACTGCGACCTAACGAGGCTCTTAWCCYGTGAGGCGGTGTGCTGTTTCCGTTCCGTGTCTCTGTCTCACCTTGA
R L X L D C S E D X X T S G T Q Q S Q G T E T G V O L>

14970 14980 14990 15000 pol 781-810 (86) 15030 15040
CGTGGCTGTGCATGTGGCCAGCGGATATATCGAAGCCGAAGTGAATCCCTGCCGMAACTGGACAGGAACCGCTTACTTTH
GCACCGACAGTACACGGTGGCTATATAGCTTCGGCTTCACTAGGGACGGCTTTGACCTGTCTTTGGCGAATGAAAK
V A V H V A S G Y I E A E V I P A E T G Q E T A Y F>

15050 15060 15070 15080 15090 env 200-229 (150) 15120
TCCTCAAGATTARGCCTGTGGTCAGCACACAGCTCCTGCTCAACGGTAGCCTCGCTGAAGAGGAARTCRTTATCAGAAGC
AGGAGTTCTAATYCGGACACAGTCTGTGTGCGAGGACGAGTTGCCATCGGAGCGACTTCTCTTYAGYAATAGTCTTCC
X L K I X P V V S T Q L L L N G S L A E E E X X I R S>

15130 15140 15150 15160 15170 pol 406-435 (61) 15200
GAAAACYTACCRATTAACAACTGGTCCGCAAACTGAATTGGGCTTCCCAAACTACSTGCGCATCAAAGTGARGCAACT
CTTTTGRAATGGYTATTCTTGACACCGCTTTGACTTAAACCGAAGGTTTACATGACCGTAGTTTCACTYCGTTGA
E N X T X N K L V G K L N W A S Q I Y X G I K V X Q L>

15210 15220 15230 15240 15250 env 121-139 (145) 15280
GTGTAAGCTCCTGAGAGGCRCAAGCCCTCACCCCTCTGTCTGTGACACTGAATTGCACAAACGCTAACCTCATCAATC
CACATTCGAGGACTCTCCGCGCTTTCGGGAGTGGGGAGACACACTGTGACTTAAAGTGTTCGCGATTGGAGTAGTTAC
C K L L R G X K A L T P L C V T L N C T N A N L I N>

spacers 15310 15320 15330 tat 76-102 (123) 15360
TGAACTGCTCTCAAMCCAGAGGCGATAACCCCTACCGRTCCRAAGAGTCCAAGAAARAGGTCGAGTCCAGRCAGAGACA
ACTTTCGACGCTTTCGGTCTCCGCTATTGGGATGGCYAGGGYTTCTCAGGTTCTTTTTCAGCKCAGGTTCTGTCTGT
V N A A Q X R G D N P T X P X E S K K X V X S K X E T>

C4
join
C5FIGURE 15 (Cont)
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spacers 15390 15400 rev 61-90 (128) 15430 15440

GACCCCTTTTGAGCCCGCCCTCCAMCTKTCTCGGAAGGYCTGCCCAACCCCTCCCCCTCCAGCTCCCCCTCTGGA
CTGGGAAMACTCTCCCGCCCTCCAGGTGAMAGACCCCTTCRAGACGGCTTGGGCAGGGGGAGGTTCGAGGGGGGAGACCT
D P X D A A P S S X X L G R X A E P V P L Q L P P L E

15450 15460 15470 15480 15490 15500 15510 15520

AAGGCTCMACTCGACTGTAGCGAAGACMGTCGCACTCGATAAGTGGGCTCCCTGTGGAACTGGTTCRATATCWCA
TTCGACGCTGGAGCTGACATCCCTCTCGMACACTGCTGACCTATTACCCGGAGGGACACCTTGACCAAGTTATAGWGGT
R L X L D C S E D X X L D K W A S L W N W P X I X

env 450-479 (166) 15550 15560 15570 15580 15590 15600

ASTGGCTGTGGTACATTAAAGATTTTCATTATGATTGTGGGAGGCAATAAGATTGTGAGGATGTACYNACCTGTCTCCATC
TSACCGACACCATGTAATTTCTAAAGTAATACTA...CCCTCCCTTATTCTAACAGTCTACATGRKTGGACAGAGGCTAG
X W L W Y I K I F I M I V G G N K I V R M Y X P V S I

15610 15640 15650 15660 15670 15680

gag 271-300 (19)

CTCGACATTARGCAAGCCCTTAAGCAACCCCTTCAGGGATACGTGGACAGATTGCTAAGCTCCTGTGGAAAGGGAGAGGG
GAGCTGTAACTTCGCTCCGGATTCCTTGGGAAGTCCCTAATGCACCTGTAAAGCACTTGGAGACACCTTCCCTCTCC
L D I X Q G P K E P F R D Y V D R F A K L L W K G E G

15690 15700 15730 15740 15750 15760

pol 946-975 (97)

AGCCGCTCGTATTGAGGACAACTCCGACATTAAAGGTCGTGCCAGGAGAAAGGCTAAATATCAACTGAATAAGAGAA
TCCGACGACCTAACTCTGTGTAGGCTGTAAATLACGACGGCTCTCTTCCGATCTAAATAGCTTGACTTATTCTCTT
A V V I Q D N S D I X V V P R R X A K I I E L N K R

15770 15780 15790 15820 spacers

CCCAAGACTTTTGGGAAGTCAACTGGGAATCCCTCAACCTCTGGAGTCAAAAAGAAAAAGTCCGTGACAGTCCCGCT
GGGTTCTGAAAACCTTTCACGTTGACCTTAGGGAGTGGGACGACCTGACTTTTCTTTTTCAGGCACTCTCAGCCGCG
T Q D F W E V Q L G I P H P A G L K K K K S V T V A A

15850 15860 15870 15880 15910 15920

env 1-30 (137)

ATGAGACTGAAAGAGACACAGATCAACTGCCCCAATCTGTGGARGTGGGGCACAMTGATTCTGGGAMTGGTCATSATTG
TACTCTCACTTTCTCTGTCTACTTACCGGGTTAGACACCTTCACCCGCTGTACTAAGACCTTACACAGTASTAAAC
M R V K E T Q M N W P N L W X W G T X I L G X V X I C

15930 15940 15950 15960 15970 16000

pol 421-450 (62)

CTCCGCTCTCAATTAAGGTCARACAGCTCTGCAAACTGCTCAGGGGTCRAAGGCTCTCAACAGASATGTGMACTGACAG
GAGGCGGAGCTAATTCCAGTGTGTCGAGACGTTTACGAGTCCCAAGTGTTCGAGACTGTCTSTAACACTGTGACTGTC
S A S I K V X Q L A C K L L R G H X A L X R H X A R E L X P

16010 16020 16030 16040 16050 16080

nef 181-196 (191)

AGGAAGCCGAAGTCAAGTCTCAWATGGAAGTTTGACTCCCRCTCGCCCGAGACATATSGCCAGGGAAGTGCRTCCC
TCCTTCGGCTTGACCTTCAAGTWTACCTTCAAACTGAGGCGYGGAGGGGCTCTGTATASCGGTCCCTTGACGYAGGG
E E A B E L E X W K F D S X L L A X R H X A R E L X P

16090 16120 16130 16160

spacers env 570-599 (174)

GAGTCTACAAAGACTGCTGCTCTCTGAGCTCTCTGGGACRCTCCAGGCTCARGGGAGTGCRAAGGGGATGGGAAGSCCT
CTCANGATGTTTCTGACCCGACCAAGCTCGAGGACCCCTGAGGTCGGAGTTCCTGACGTTTCCCTTACCTTCSGGA
E X Y X D C A A V E B L L G X S S L X Q L Q X A L X T G W E X L

16170 16180 16190 16200 16210 16220 16230 16240

CAAGTATTGKGGAACTCTCTGCTGATTGGGGCTCTGGRCACCTGCAAYCTGCTCTGMAAACCGGACAGAGG
GTTTCATAAMCHCCTTGGAGGACGCATAACCCCTGAGCTGCTGACGTTTGGCTTGTCTCC
X Y X X N L L X Y W G S S L X Q L Q X A L X T G W E X

gag 61-90 (5) 16270 16280 16290 16300 16310 16320

AAGTGARGTCCCTGTWTAACACARTCCCTACCCCTCTGGTGTGTGCATCAGAGCTCTACAAATACAAAGTGGTCRAAATC
TTGACTYTCAGGACANATTTGTGTAGCGATGGGAGACCAACACAGTAGTCTCGAGATGTTTATGTTTCACCGAGTTTATG
E L X S L X N T X A T L W C V L X Y K Y K V X V X I

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16330 env 270-299 (154) 16360 16370 16380 16390 16400

RAACCCCTCGCCTTGGCCCTACCARAGGCAAAAGGAGAGTGCTCAGAGAGAGAAAAGCTCACCCGANATCGTCMACT
YTTGGGGAGCGGYAACGGGGATGGTYTTCGGTTTCTCTCTCACCAGSTCTCTCTCTTTTCGAGTGGCTWTAGCAGKGTGA
X P L G X A P T X A K R R V V X R E K R L T X I V X L>

16410 16420 pol 436-465 (63) 16450 16460 16470 16480

CACCGAAGAGGCTGAGCTGGAGCTGGMGAAAAACAGAGATTCTGAROGAACCCGCTCCACGGAGTGTATAGACTGCTCG
GTGGCTTCTCCGACTCGACTCGACCKCCTTTTCTCTCTTAAGACTYCCTTGGGCAGGTGCCTACATACTCAGCAGC
T E E A E L E L X E N R E I L X E P V H G V Y R V L>

16490 16500 16510 gag 361-390 (25) 16540 16550 16560

CCGAAGCCATGAGCCAAGYCAMCMATGCCAACATCATGATCCAGAGAGGCAATTTCARAGGCCCHAAAGAGAATCRTCAA
GGCTCTCGGTACTCGGTCTCRKTACGGTGTAGTACTACGTCTCTCCGTTAAAGTYTCCGGKTTTCTCTTAGYAGTTT
A B A M S Q X X X A N I M M Q R G N P X G X K R I X K>

16570 16580 16590 16600 nef 61-90 (183) 16630 16640

CANAGGAAGAGGRTGGCTTCCCCTCAGGCTCCACTGAGACCTATGACCTACAAAGSAGCCRTCGATCT
GTCTCTCTCTCTCTCCAGCCGAAGGGGAGTCCGGAGTCCAGGGTGACTCTGGATACTGGATOTTCTSCCGYAGCTAGA
Q E E E X V G P F V R P Q V P L R P M T Y K X A X D L>

16650 16660 16670 16680 16690 gag 286-315 (20) 16720

GTCCTTCTTARACAGGACCCAAAGAGCCTTTCAGAGACTATGTGGATAGGTTTTWCAAAACCCCTCAGGGCTGAGCAAG
CAGCRAGAAATTTGTCCCTGGGTTTCTCGGAAAGTCTCTGATACACTATCCAAAGTTTGGGAGTCCCGACTGTTT
S X P X Q G P K E F F R D Y V D R F X K T L R A E Q>

16730 16740 16750 16760 16770 gag 16-45 (2) 16800

CCWCACAGGANGTGA AAAATCGGGAGAAAATCAGACTGAGACCTCGTGGCAAAAAGAAATACARAHTGAAACACMTGTG
GGHGTCTCTACTCTTTTACCCCTCTTTAGTCTGACTCTGACCACCGTTTCTCTTTATCTTTACTTTGTGAACAC
A X Q X V K N W E K I R L R P G G K K X Y X X K H X V>

16810 16820 16830 16840 16850 pol 646-675 (77) 16880

TGGGCTCCAGGGAAGTGAAGAGTTTGCTTCCAGTATGCCCTCGGCATCATCCWAGCCCAACCCGATARGTCCGAGTC
ACCCGGAGGTCCCTTGACCTTTTCCAAACGAGGGGTACATACGGGAGCCGCTAGTAGGNTCCGGTTGGCTATTACGGCTCAG
N A S R E L E R F A S Q Y A L G I X K A Q P D X S E>

16890 16900 16910 16920 16930 16940 16950 16960

CCAGSTCGTGARTCAGATTATCGAAVAGCTCATCANGAATTCGCGTCGCCGRAKGGACACAGARTCATTGAGTGG
GCTCSAGCACTYACTCTAATAGCTTBTCCAGTAGTCTTTTACGGCCAGCGCTTWCCTGTCTGTCTYAGTAECTCAGC
E X V X Q I I E X L I K K I A V A X X X T D R X I E V>

env 615-644 (177) 16990 17000 17010 17020 17030 17040

YCCAAAGGCGCTKGAGAGCCATTTCTGMATATCCCCASGAGAATCAGACA [REDACTED] CTGCGCGGAAGGTGGCCCGCTCARG
RGGTTTCCCGAMCCTCTCGGTAAAGCATATAGGGGTSCTCTTAGTCTCTG [REDACTED] GAGCGGCGCTTCCACCGCGCAGTYC
X Q R A X R A I L X I T Y P X R I R Q T R L A G R W P V X>

17050 pol 811-840 (88) 17080 17090 17100 17110 17120

RYAATCCATACCGATAACGGAAGCAATTTCAACAGCRCTRCCGTCAGGGCTGCCCTGCTGCTGCTCATGTGARACAGCT
YRTTAGGTATGGCTATTGCCCTTCGTTAAAGTGTCTCYGAYGECAGTCTCCAGCGACGACCACCGCTACACTYTTGCGA
X I H T D N G S N F T S X C V K A A C X G W A D V X Q L>

17130 17140 pol 511-540 (68) 17170 17180 17190 spacers

CACCGHAGYCGTCCAGAAARTCGCTACCGAAAGCATTGTGATATGGGGAAAGACACCTCAAGTTCARCTAGCCTATCGCTC
TGCGCTCTRCGAGGCTCTTYAGCGATGGCTTTCGTAACACTATAACCCCTTCTGTGGCGTCAAGTYTACCGGATACGAC
T X X V O K K X A T E S I V I W G R T P K F X L P I A>

FIGURE 15 (Cont)

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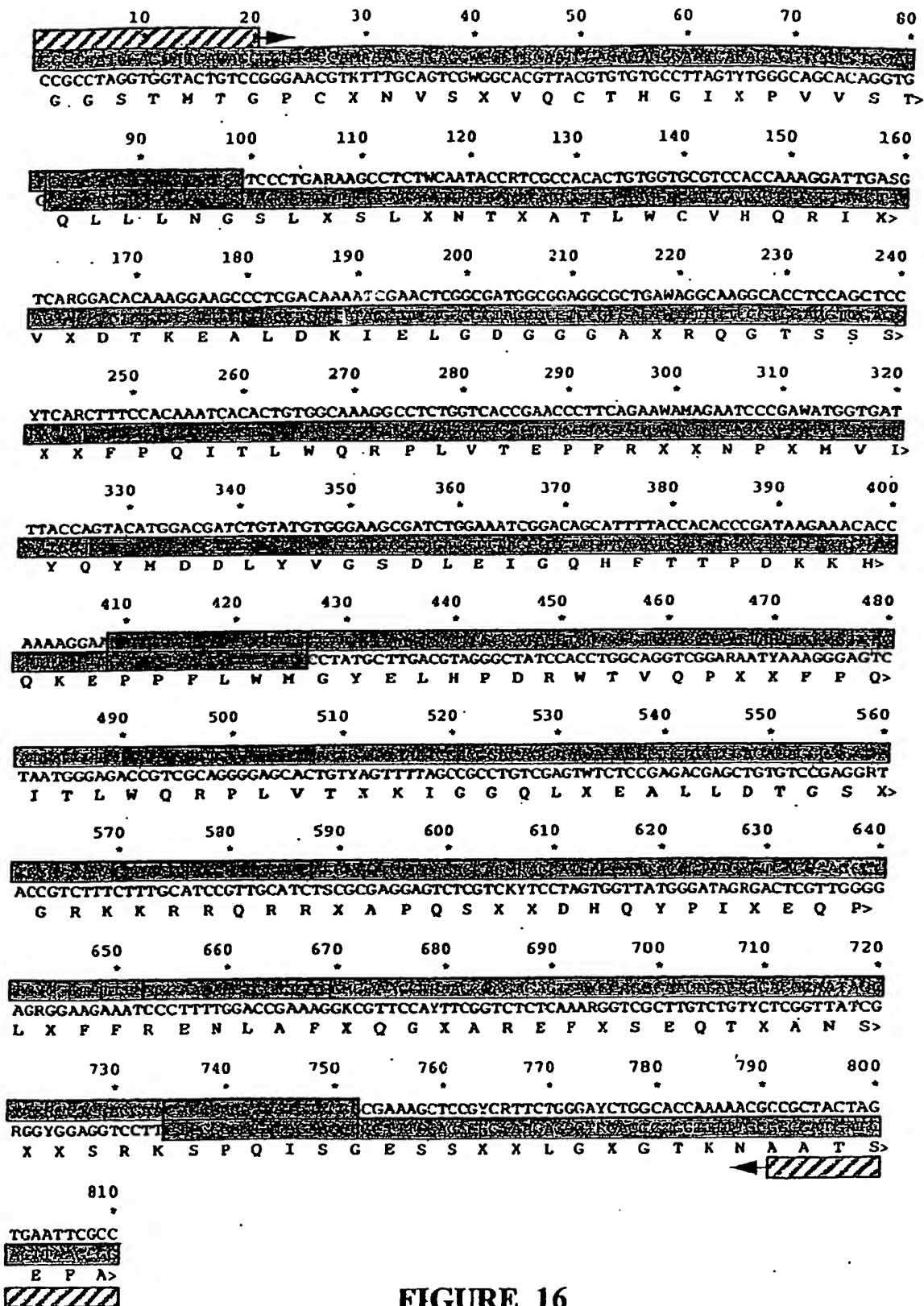
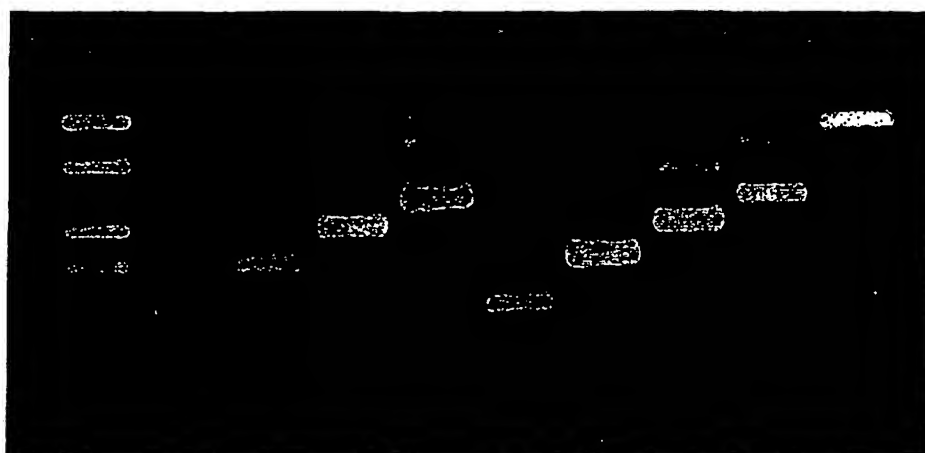


FIGURE 16

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A 1 2 3 4 5 6 7 8 9 10



B — A —||— B —||— C —



FIGURE 17

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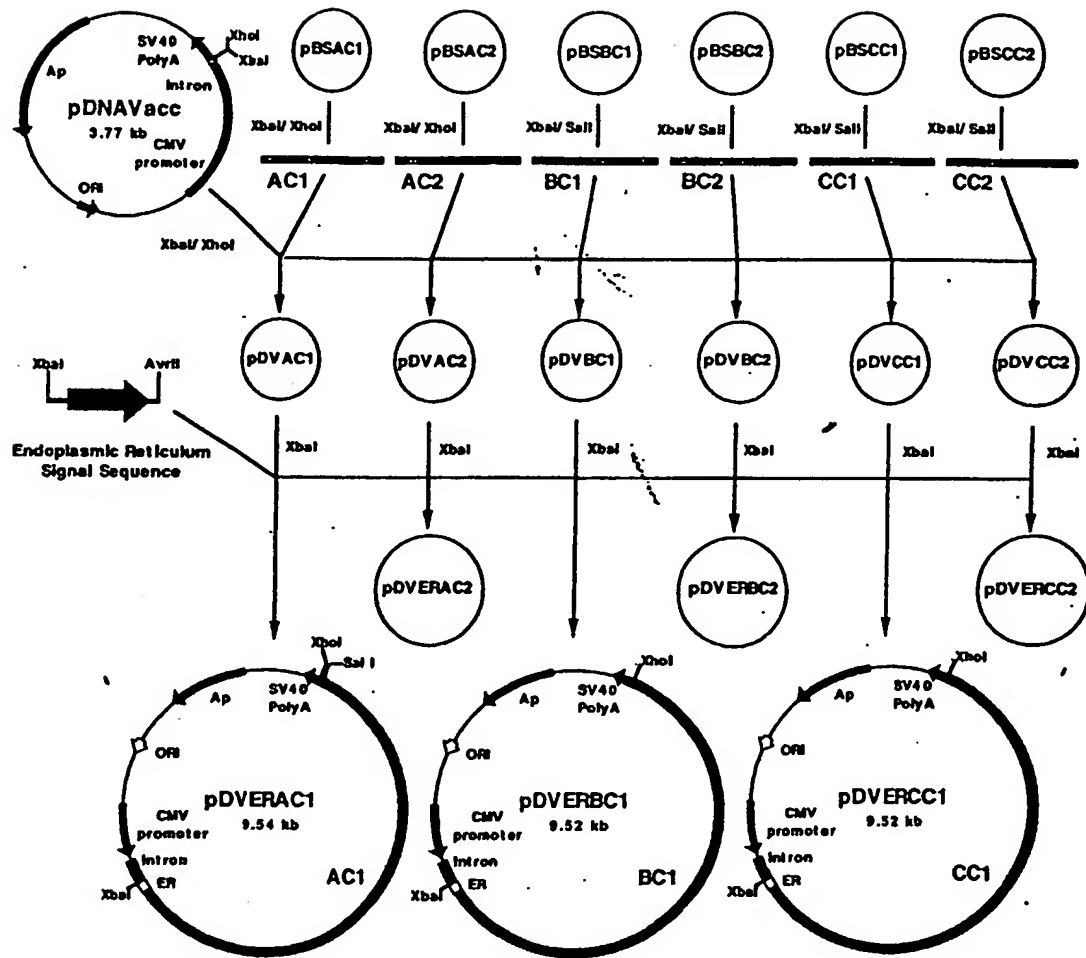


FIGURE 18A

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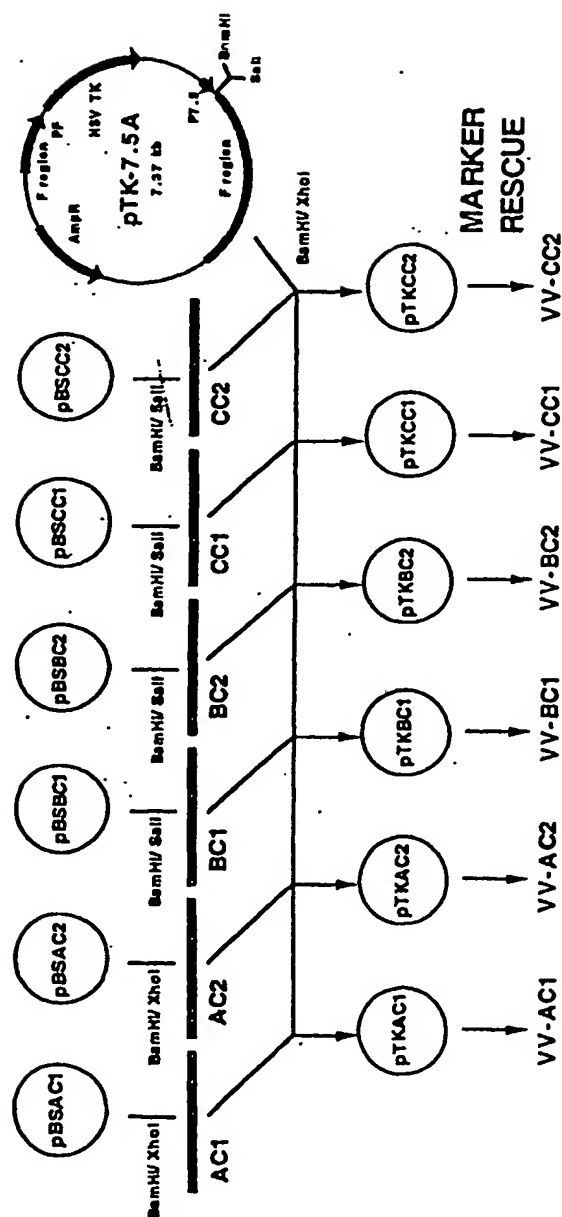


FIGURE 18B

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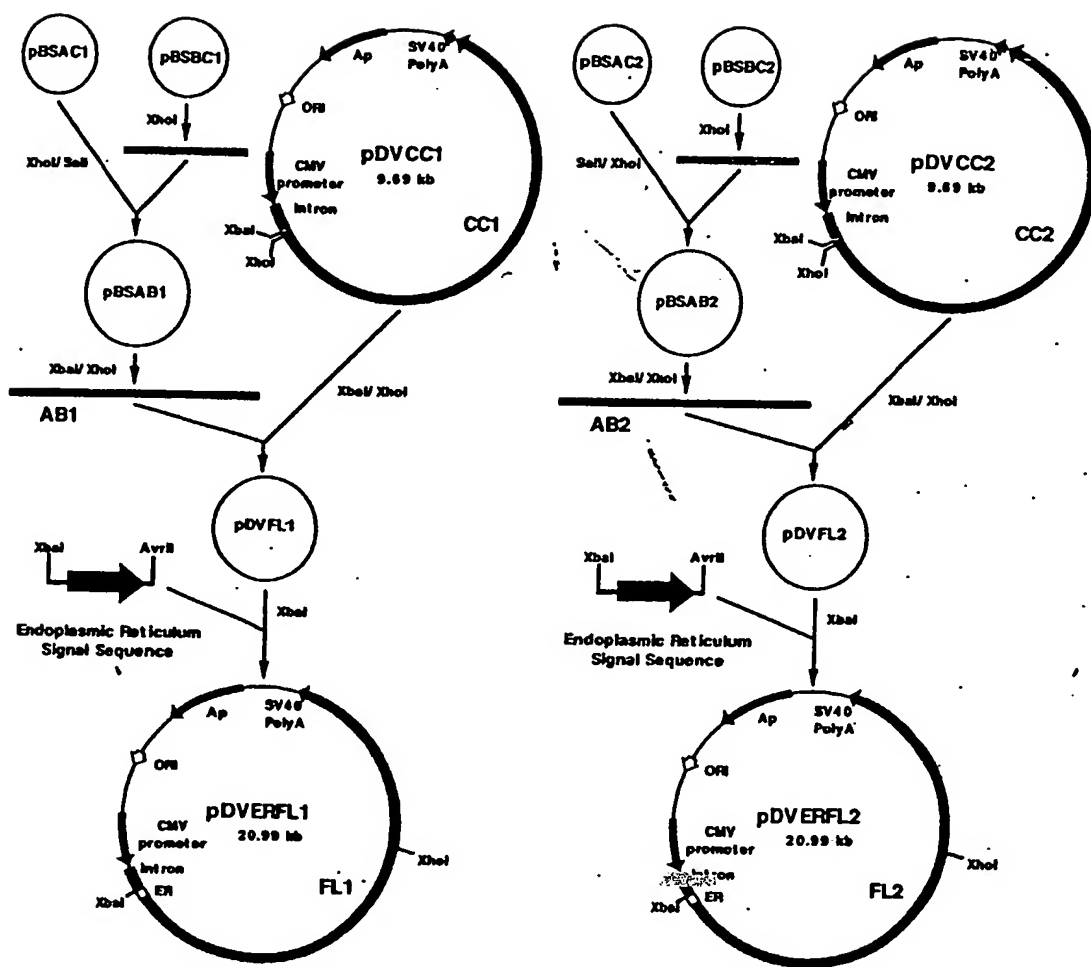
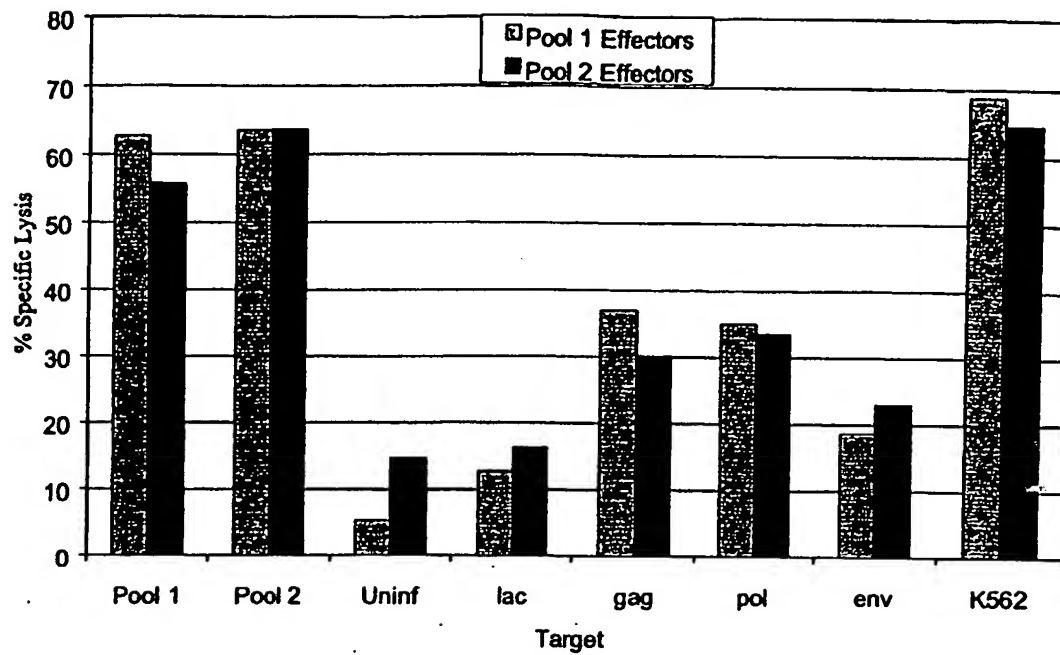


FIGURE 18C

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Subject1



Subject2

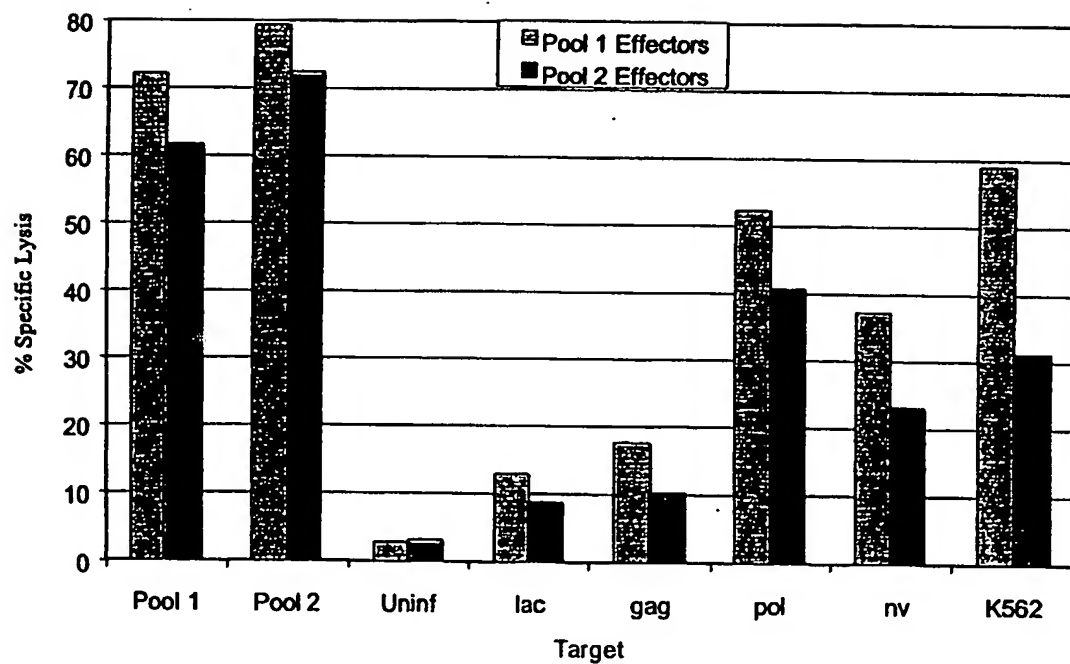


FIGURE 19

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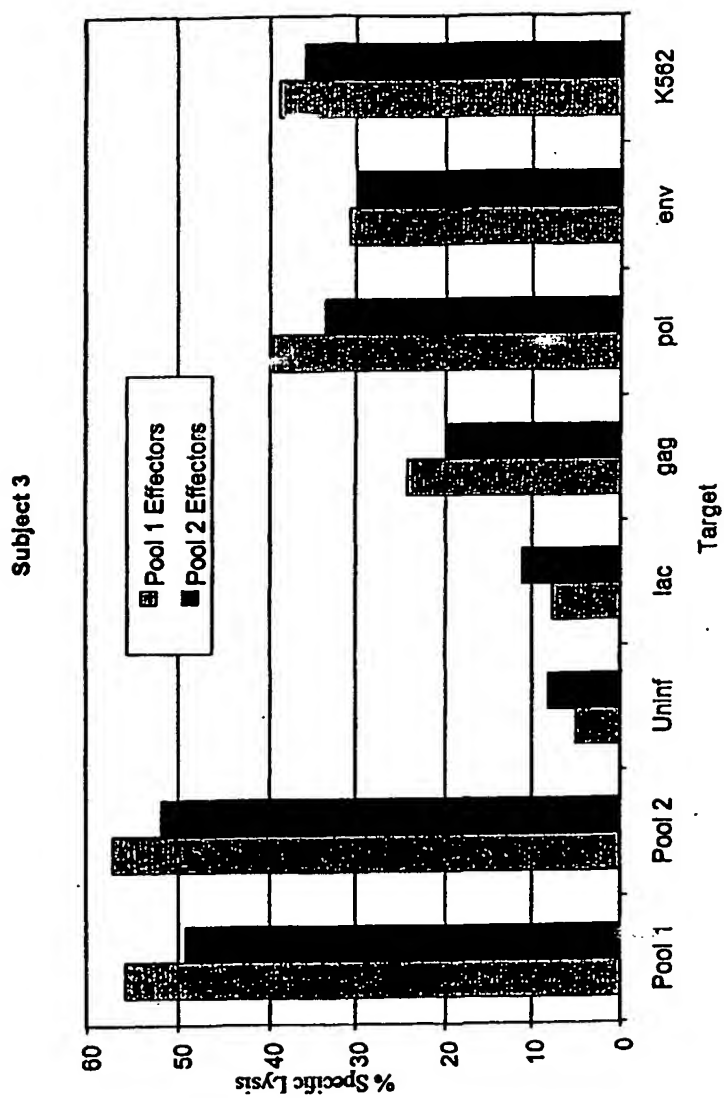


FIGURE 19 (Cont)

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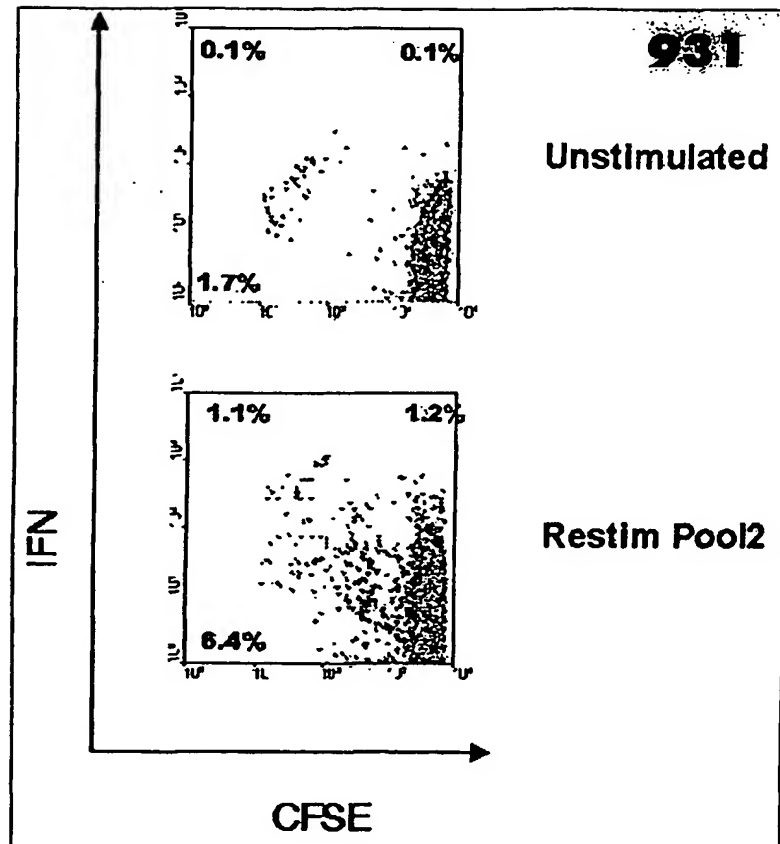


Figure 20

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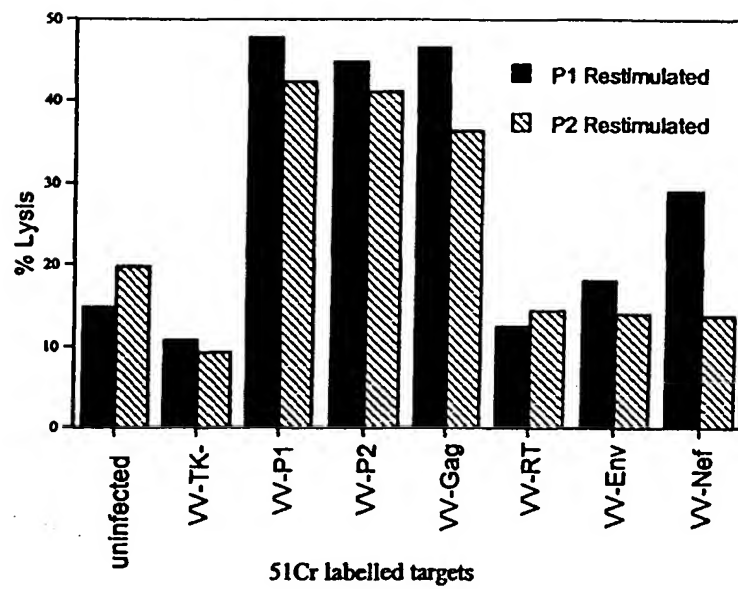


Figure 21

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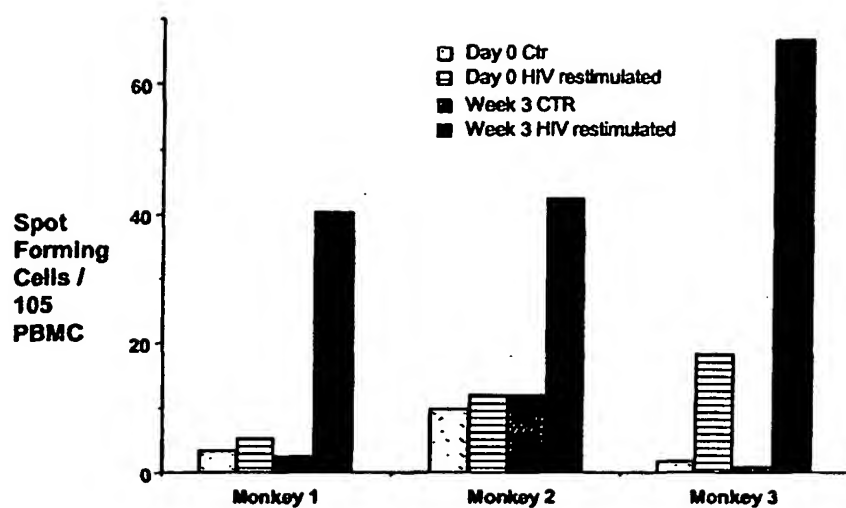


Figure 22A

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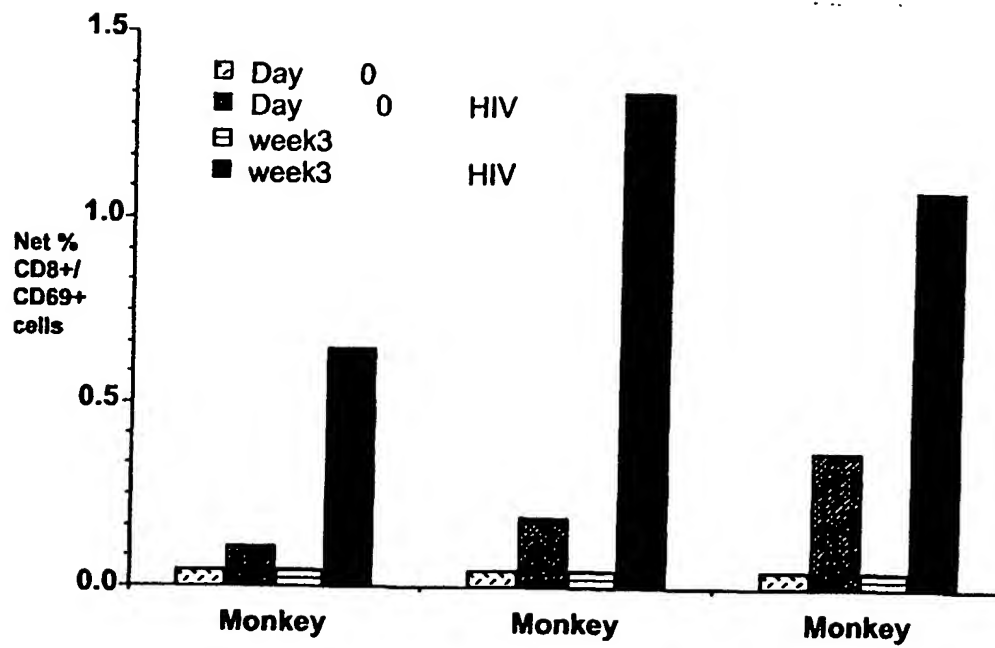


Figure 22B

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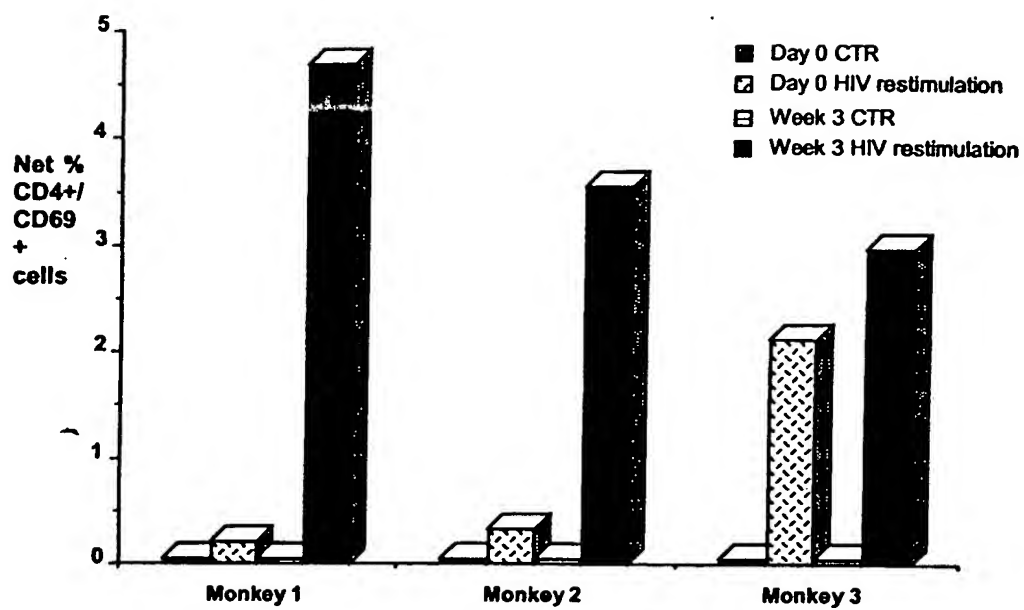


Figure 22C

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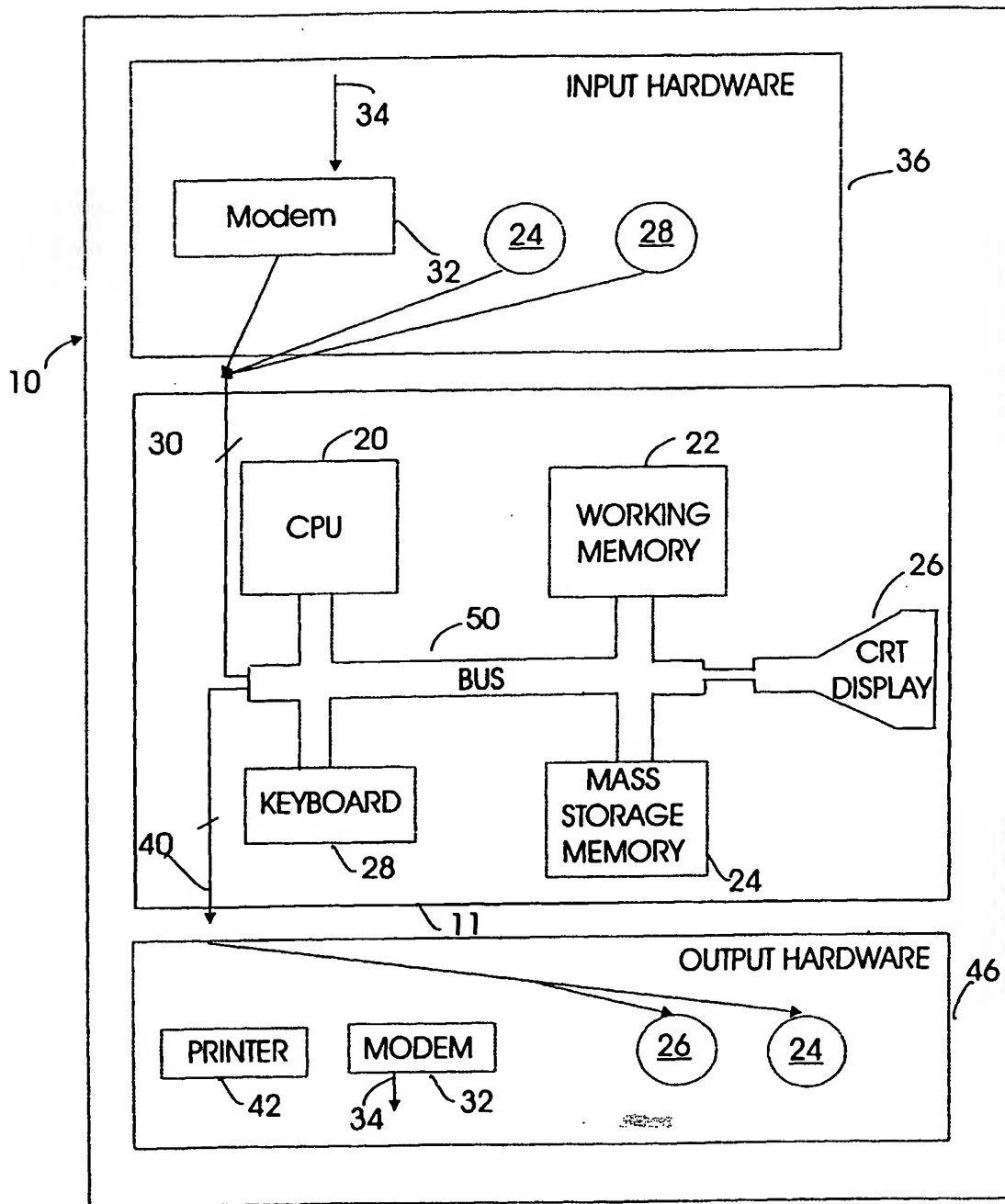


FIGURE 23

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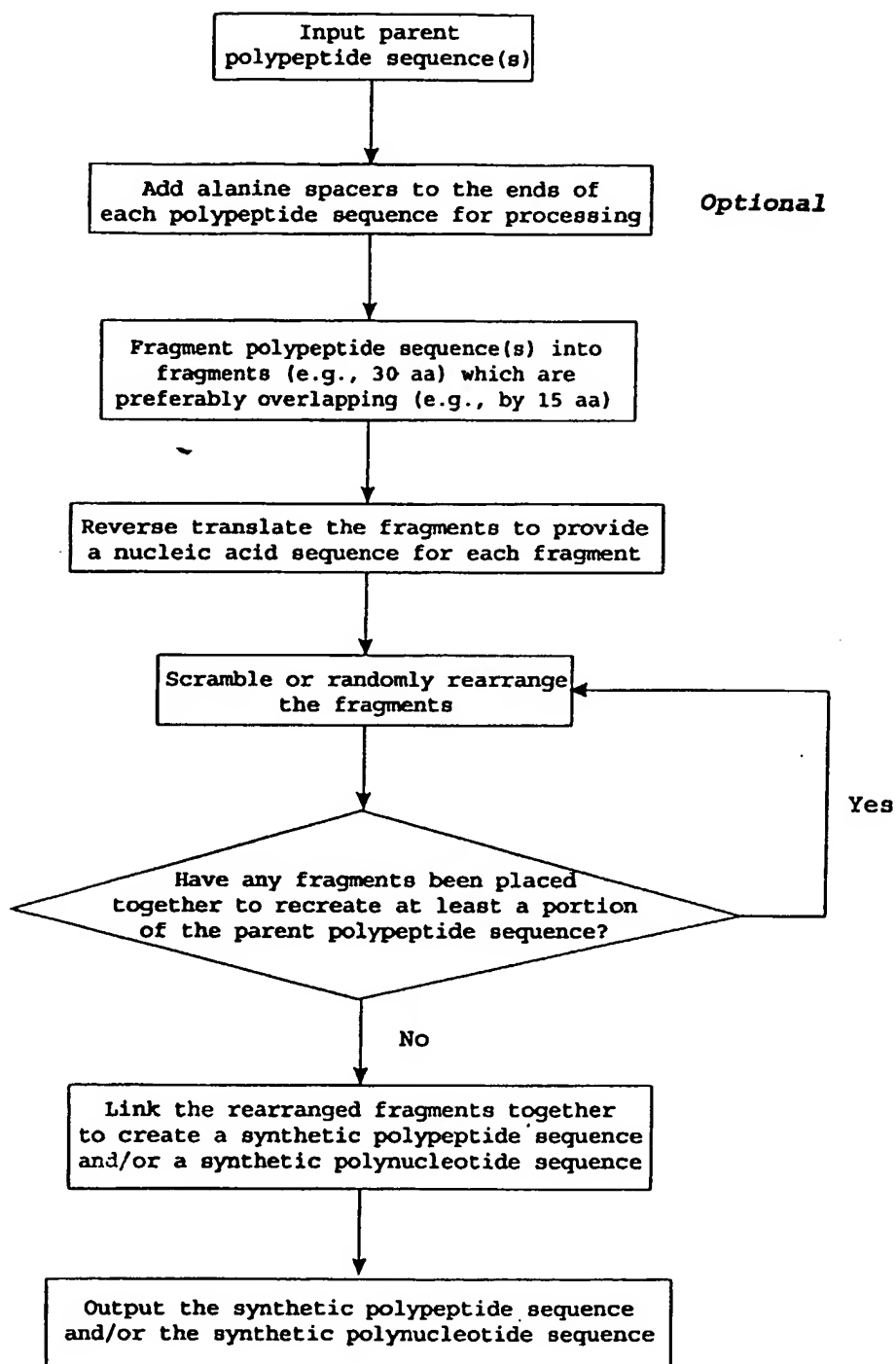


Figure 24

```

/* Scramble */
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/* Includes */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <time.h>

/* Constant definitions */

/* Version Information */
#define VERSION_NO "0.2"
#define VERSION_DATE "04/03/1999"

/* Misc */
#define KEYBOARD_BUFFER_SIZE 256 /*size of keyboard read buffer */
#define LEN_CODON 4 /*length of codon (including
null) */
#define BUFFER_SIZE 10000 /*size of file read buffer */
#define TRUE 1 /*boolean true */
#define FALSE 0 /*boolean false */

/* Error codes */
#define E_NOERROR 0 /*no error */
#define E_NOINFILE 1 /*genes file not found */
#define E_MALLOC 2 /*memory allocation error */
#define E_FILEREAD 3 /*file read error */
#define E_CREATE_OUTPUT_FILE 4 /*error creating output file */
#define E_OVERLAP 5 /*segment overlap >= length

/* Structure definitions */

typedef struct gene GENE;
typedef GENE * P_GENE;
typedef struct gene_segment GENE_SEGMENT;
typedef GENE_SEGMENT * P_GENE_SEGMENT;
struct gene {
    char * name;
    char * data;
    P_GENE next_gene;
};

struct gene_segment {
    P_GENE p_gene;
    int number;
    int offset;
    int first_codon_choice;
    char * amino_data;
    char * dna_data;
    P_GENE_SEGMENT next_seg;
};

```

Figure 25

/* Function prototypes */

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```

int prolog();
int g_t_parameters();
int read_int(char * prompt);
int load_genes();
int add_gene(char * gene_name, char * gene_data);
void insert_gene(P_GENE * head, P_GENE new_gene);
int add_aa();
int split_genes();
int split_gene(P_GENE g);
int insert_segment(P_GENE_SEGMENT * head_seg, P_GENE_SEGMENT new_seg);
int convert_segments_aa_to_dna();
int convert_aa_to_dna(char * aa_ptr, char * dna_ptr, int first_choice);
char * codon(char acid_char, int preferred);
int perform_scramble();
int scramble_segments();
int adjacent_segments();
int display_genes();
int write_output_file();
void strip_newline(char * strip_str);
void pad_amino_string(char * amino_ptr, char * padded_ptr);
int even(int test_num);
void read_str(char * prompt, char * string);
char * read_nonblank_line(char * buf, int buf_size, FILE * in_file);
int user_confirmation();
void test();

```

/* Global variables */

```

char * codon_table[26][2] = {
/* A 00 */ {"GCC", "GCT"},
/* - 01 */ {"???", "???"},
/* C 02 */ {"TGC", "TGT"},
/* D 03 */ {"GAC", "GAT"},
/* E 04 */ {"GAG", "GAA"},
/* F 05 */ {"TTC", "TTT"},
/* G 06 */ {"GGC", "GGA"},
/* H 07 */ {"CAC", "CAT"},
/* I 08 */ {"ATC", "ATT"},
/* - 09 */ {"???", "???"},
/* K 10 */ {"AAG", "AAA"},
/* L 11 */ {"CTG", "CTC"},
/* M 12 */ {"ATG", "ATG"},
/* N 13 */ {"AAC", "AAT"},
/* - 14 */ {"???", "???"},
/* P 15 */ {"CCC", "CCT"},
/* Q 16 */ {"CAG", "CAA"},
/* R 17 */ {"AGG", "AGA"},
/* S 18 */ {"AGC", "TCC"},
/* T 19 */ {"ACC", "ACA"},
/* - 20 */ {"???", "???"},
/* V 21 */ {"GTG", "GTC"},
/* W 22 */ {"TGG", "TGG"},

```

Figure 25 (Cont)

```

/* - 23 */ {"???", "???"},
/* Y 24 */ {"TAC", "TAT"},
/* - 25 */ {"???", "???"},
};

```

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```

char * error_text[] = {
/* 00 */ ""
/* 01 */ "ERROR: Input file not found!"
/* 02 */ "ERROR: Memory allocation error"
/* 03 */ "ERROR: File read error"
/* 04 */ "ERROR: Could not create output file"
/* 05 */ "ERROR: Segment overlap must be less than segment length"
};

```

```

char disease_name[KEYBOARD_BUFFER_SIZE];
char input_file_name[KEYBOARD_BUFFER_SIZE];
char output_file_name[KEYBOARD_BUFFER_SIZE];
int num_genes = 0;
int num_segments = 0;
int len_segment;
int segment_overlap;
P_GENE first_gene = NULL;
P_GENE_SEGMENT first_segment = NULL;
P_GENE_SEGMENT * scrambled_segments = NULL;

```

```

/* Mainline */

```

```

void main() {
    int error = E_NOERROR;

    printf("Scramble - Version %s, %s\n\n", VERSION_NO, VERSION_DATE);

    /* Initial processing */
    if (!error)
        error = prolog();

    /* Get various program parameters from user */
    if (!error)
        error = get_parameters();

    /* Load genes from genes file */
    if (!error)
        error = load_genes();

    /* Add 'AA' to start and end of all genes */
    if (!error)
        error = add_aa();

    /* Split genes into overlapping chunks */
    if (!error)
        error = split_genes();

    /* Convert segment amino acid to dna */
    if (!error)
        error = convert_segments_aa_to_dna();
}

```

Figure 25 (Cont)


```

/* Scramble the segments */
if (!error)
    err = perform_scramble();

/* Write output file */
if (!error)
    error = write_output_file();

/* Show error if there was one */
if (error)
    printf("%s\n", error_text[error]);
}

/* prolog() */
/* Perform any initial processing required */
int prolog() {
    /* Seed the random number generator, using the system clock */
    /* Don't run the program more than once in the same second! */
    /* Or we'll get the same randomisation!!!!!!!!!!!!!!!!!!!! */
    srand(time(NULL));

    return E_NOERROR;
}

/* get_parameters() */
/* Ask for various parameters from the user (stdin) */
/* Disease name */
/* Input file name */
/* Output file name */
/* Segment length */

int get_parameters() {
    int valid;

    read_str("Enter disease name : ", disease_name);
    read_str("Enter input file name : ", input_file_name);
    read_str("Enter output file name : ", output_file_name);

    valid = FALSE;
    while (!valid) {
        len_segment = read_int("Enter segment length : ");
        if (len_segment % 2)
            printf("Segment length must be even!\n");
        else
            valid = TRUE;
    }
    segment_overlap = len_segment / 2;

    return E_NOERROR;
}

/* load_genes() */

```

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Figure 25 (Cont)

/* Load the genes from the input file */

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```

int load_genes() {
    FILE * input_file;
    char name_buf[BUFFER_SIZE];
    char data_buf[BUFFER_SIZE];
    int rc;

    /* Open genes file for reading */
    if (NULL == (input_file = fopen(input_file_name, "r")))
        return E_NOINFILE;

    printf("Loading genes from: %s\n", input_file_name);
    num_genes = 0;
    /* Read gene name */
    while (NULL != read_nonblank_line(name_buf, BUFFER_SIZE, input_file)) {
        /* Read the gene data */
        if (NULL != read_nonblank_line(data_buf, BUFFER_SIZE, input_file)) {
            /* Allocate memory for new gene and add to list */
            if (rc = add_gene(name_buf, data_buf))
                break;
        }
    }
    /* Close genes file */
    fclose(input_file);

    return rc;
}

/* add_gene() */
/* Allocate memory for new gene, then insert in list */

int add_gene(char * gene_name, char * gene_data) {
    P_GENE new_gene;

    /* Allocate storage for new gene */
    if (NULL == (new_gene = malloc(sizeof(GENE))))
        return E_MALLOCC;
    /* Initialise new gene */
    new_gene->next_gene = NULL;
    /* Allocate storage for gene name (+1 for null) */
    if (NULL == (new_gene->name = malloc(strlen(gene_name)+1)))
        return E_MALLOCC;
    /* Store gene name */
    strcpy(new_gene->name, gene_name);
    /* Allocate storage for gene data (+1 for null) */
    if (NULL == (new_gene->data = malloc(strlen(gene_data)+1)))
        return E_MALLOCC;
    /* Store gene data */
    strcpy(new_gene->data, gene_data);
    /* Insert the new gene into linked list */
    insert_gene(&first_gene, new_gene);
    /* Increment num_genes */
    num_genes++;
}

```

Figure 25 (Cont)

```

        return E_NOERROR;
    }

    /* insert_gene() */
    /* Insert gene into linked list */

    void insert_gene(P_GENE * head_gene, P_GENE new_gene) {
        P_GENE * cur_ptr = head_gene;

        while (NULL != (*cur_ptr))
            cur_ptr = &((*cur_ptr)->next_gene);

        *cur_ptr = new_gene;
    }

    /* add_aa() */
    /* Add 'AA' to the start and end of every gene */

    int add_aa() {
        P_GENE cur_gene = first_gene;
        char * new_data;

        while (NULL != cur_gene) {
            /* Allocate storage to fit the gene plus four characters */
            new_data = malloc(strlen(cur_gene->data)+5);
            /* Shift gene data to new storage, add "AA" */
            strcpy(new_data, "AA");
            strcat(new_data, cur_gene->data);
            strcat(new_data, "AA");
            /* Free previous gene data storage */
            free(cur_gene->data);
            /* Set gene data pointer to new storage */
            cur_gene->data = new_data;
            /* Advance to next gene */
            cur_gene = cur_gene->next_gene;
        }

        return E_NOERROR;
    }

    /* split_genes() */
    /* Split the genes into overlapping segments */

    int split_genes() {
        P_GENE cur_gene = first_gene;
        P_GENE_SEGMENT cur_seg = first_segment;

        printf("Splitting genes into segments...\n");

        /* Split the genes into segments */
        while (NULL != cur_gene) {
            /* Split the gene */
            split_gene(cur_gene);
            /* Advance to next gene */
        }
    }

```

Figure 25 (Cont)

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```

        cur_gene = cur_gene->next_gene;
    }

    /* Count the number of segments */
    num_segments = 0;
    cur_seg = first_segment;
    while (NULL != cur_seg) {
        num_segments++;
        cur_seg = cur_seg->next_seg;
    }

    return E_NOERROR;
}

/* split_gene() */
/* Split a gene into overlapping segments */

int split_gene(P_GENE g) {
    char * seg_ptr;
    char * seg_buf;
    P_GENE_SEGMENT new_segment = NULL;
    int done;
    int seg_ctr = 0;

    /* Allocate memory for segment buffer */
    if (NULL == (seg_buf = malloc(len_segment+1)))
        return E_MALLOCC;

    /* Insert a null at the end of the segment buffer, */
    /* so we can use it as a string */
    seg_buf[len_segment] = '\0';

    /* Set segment pointer to start of gene data */
    seg_ptr = g->data;

    done = FALSE;
    while (!done) {
        /* So we know if we copied data */
        seg_buf[0] = '\0';

        /* Copy a segment of gene data to the segment buffer */
        memcpy(seg_buf, seg_ptr, len_segment);

        /* If there was some gene data copied to the buffer */
        if (NULL != seg_buf[0]) {
            /* Allocate storage for a new segment */
            if (NULL == (new_segment = malloc(sizeof(GENE_SEGMENT))))
                return E_MALLOCC;

            /* Increment segment counter */
            seg_ctr++;

            /* Setup the new segment */
            new_segment->p_gene = g;
            new_segment->number = seg_ctr;
            new_segment->offset = seg_ptr - g->data + 1;
            new_segment->next_seg = NULL;
        }
    }
}

```

Figure 25 (Cont)

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```

        if (NULL == (new_segment->amino_data = malloc(len_segment+1)))
            return E_MALLOCC;
        if (NULL == (new_segment->dna_data = malloc(len_segment*3+1)))
            return E_MALLOCC;
        new_segment->amino_data[0] = '\0';
        new_segment->dna_data[0] = '\0';
        /* Copy segment data from buffer to new segment */
        strcpy(new_segment->amino_data, seg_buf);
        /* Insert new segment into chain from gene */
        insert_segment(&first_segment, new_segment);
    }

    /* If we didn't read a full segment, we are finished! */
    if (strlen(seg_buf) < len_segment)
        done = TRUE;
    /* Otherwise, advance segment pointer to next segment in buffer */
    else
        seg_ptr = seg_ptr + len_segment - segment_overlap;
}

/* insert_segment() */
/* Insert a segment node at the end of the list */

int insert_segment(P_GENE_SEGMENT * head_seg, P_GENE_SEGMENT new_seg) {
    P_GENE_SEGMENT * cur_ptr = head_seg;

    while (NULL != (*cur_ptr))
        cur_ptr = &((*cur_ptr)->next_seg);

    *cur_ptr = new_seg;
}

/* convert_segments_aa_to_dna */
/* Go thru segments, and for each, convert amino acids to dna */

int convert_segments_aa_to_dna() {
    P_GENE_SEGMENT cur_seg = first_segment;
    int first_choice = 1;
    int alternate;

    printf("Converting to DNA...\n");

    /* Work out if we need to alternate the first codon choice or not */
    /* Don't need to do this anymore, since the segment length is */
    /* forced to be even, and the overlap is half the length (odd). */
    /* alternate = ((even(len_segment) && even(segment_overlap))
        || (leven(len_segment) && leven(segment_overlap))); */
    alternate = FALSE;

    while (NULL != cur_seg) {
        cur_seg->first_codon_choice = first_choice;
        convert_aa_to_dna(cur_seg->amino_data, cur_seg->dna_data,
            cur_seg->first_codon_choice);
    }
}

```

Figure 25 (Cont)

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```

        /* Address next segment */
        cur_seg = cur_seg->next_seg;

        /* If we are alternating, alternate the first codon choice */
        /*if (alternate)
            if (1 == first_choice)
                first_choice = 2;
            else
                first_choice = 1;*/
    }

    return E_NOERROR;
}

/* convert_aa_to_dna */
/* Converts a string of amino acid to dna */
/* NOTE: assumes that buffer at dna_ptr is large enough to hold dna!!! */

int convert_aa_to_dna(char * aa_ptr, char * dna_ptr, int first_choice) {
    char * p_codon;
    int cur_preferred = first_choice;

    while (*aa_ptr != '\0') {
        p_codon = codon(*aa_ptr, cur_preferred);
        strcat(dna_ptr, p_codon);
        /* If we didn't find a codon, log a warning */
        if (0 == strcmp(p_codon, "???"))
            printf("WARNING: no codon found for amino acid!\n");

        /* Alternate current preferred codon */
        if (1 == cur_preferred)
            cur_preferred = 2;
        else
            cur_preferred = 1;

        aa_ptr++;
    }

    return E_NOERROR;
}

/* codon */
/* Returns a pointer to a codon corresponding to the amino acid passed */
/* The codon pointer is to 3 characters, plus a terminating null */

char * codon(char acid_char, int preferred) {
    int codon_table_index;
    char * codon_ptr;

    /* Determine index into codon_table (table starts at 'A') */
    codon_table_index = acid_char - 'A';

    /* Set pointer to appropriate codon */
    codon_ptr = codon_table[codon_table_index][preferred-1];
}

```

Figure 25 (Cont)

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```

        return codon_ptr;
    }

/* display_genes() */
/* Display the name and data for all genes */

int display_genes() {
    P_GENE cur_gene = first_gene;

    while (NULL != cur_gene) {
        printf("%s\n", cur_gene->name);
        printf("%s\n", cur_gene->data);
        cur_gene = cur_gene->next_gene;
    }

    return E_NOERROR;
}

/* perform_scramble() */
/* Scramble the segments */
/* Check for adjacent segments. If there are, rescramble */

int perform_scramble() {
    int done = FALSE;
    int rc = E_NOERROR;

    while (TRUE) {
        rc = scramble_segments();
        if (E_NOERROR == rc)
            if (adjacent_segments()) {
                printf("Adjacent segments detected! Rescramble? (y/n) ");
                if (user_confirmation()) {
                    printf("WARNING: Adjacent segments in output
file.\n");
                    break;
                }
            }
            else
                break;
        else
            break;
    }

    return rc;
}

/* scramble_segments() */
/* Randomly scramble the segments, putting pointers in scrambled_segments[] */

int scramble_segments() {
    P_GENE_SEGMENT cur_seg = first_segment;
    int i, j;
    P_GENE_SEGMENT temp;

    printf("Scrambling segments...\n");

```

Figure 25 (Cont)

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```

/* Allocate storage for array of segment pointers */
if (NULL == (scrambled_segments = malloc(sizeof(P_GENE_SEGMENT)*num_segments)))
    return E_MALLOCC;

/* First, initialise scrambled_segments in same order as linked list */
i = 0;
while (cur_seg != NULL) {
    scrambled_segments[i] = cur_seg;
    cur_seg = cur_seg->next_seg;
    i++;
}

/* Now, randomly scramble the segments */
for (i=0;i<num_segments;i++) {
    j = rand() % num_segments;
    temp = scrambled_segments[i];
    scrambled_segments[i] = scrambled_segments[j];
    scrambled_segments[j] = temp;
}

return E_NOERROR;
}

/* adjacent_segments() */
/* Determine if the scrambled segment order has resulted in */
/* two segments which were adjacent originally (ie every */
/* second one) have ended up adjacent. */

int adjacent_segments() {
    int i;
    int rc = 0;
    P_GENE_SEGMENT cur_seg;
    P_GENE_SEGMENT next_seg;

    for (i=0;i<num_segments-1;i++) {
        /* Address current and next segments */
        cur_seg = scrambled_segments[i];
        next_seg = scrambled_segments[i+1];
        /* Do segments come from same gene, and are two apart? */
        if (((cur_seg->p_gene == next_seg->p_gene)
            && ((cur_seg->number == (next_seg->number)+2)
            || (cur_seg->number == (next_seg->number)-2))))
            return 1;
    }
    return 0;
}

/* write_output_file() */
/* Write out segments (in initial non-scrambled order) */
/* Write out synthetic protein (in scrambled order) */
/* Write out synthetic dna (in scrambled order) */

int write_output_file() {
    FILE * output_fil ;

```

Figure 25 (Cont)

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```

char * amino_buffer;
P_GENE_SEGMENT cur_seg;
int i;

/* Open output file for writing (erase any contents) */
if (NULL == (output_file = fopen(output_file_name,"w")))
    return E_CREATE_OUTPUT_FILE;

/* Allocate memory for padded amino string buffer */
if (NULL == (amino_buffer = malloc(len_segment*3+1)))
    return E_MALLOCC;

printf("Writing output file: %s\n",output_file_name);

/* Write output file header information */
fprintf(output_file,"Scramble %s - Output File\n",VERSION_NO);
fprintf(output_file,"\n");
fprintf(output_file,"Disease name   : %s\n",disease_name);
fprintf(output_file,"Input filename  : %s\n",input_file_name);
fprintf(output_file,"Output filename : %s\n",output_file_name);
fprintf(output_file,"Number genes   : %d\n",num_genes);
fprintf(output_file,"Number segments : %d\n",num_segments);
fprintf(output_file,"Segment length  : %d\n",len_segment);
fprintf(output_file,"Segment overlap : %d\n",segment_overlap);

/* Write out segments in initial non-scrambled order */
fprintf(output_file,"\n");
fprintf(output_file,"Segments in original order:\n");
fprintf(output_file,"-----\n");
cur_seg = first_segment;
while (NULL != cur_seg) {
    /* Format amino data to line up with codons */
    pad_amino_string(cur_seg->amino_data,amino_buffer);
    fprintf(output_file,"Gene      : %s\n",cur_seg->p_gene->name);
    fprintf(output_file,"Segment# : %d\n",cur_seg->number);
    fprintf(output_file,"Offset   : %d\n",cur_seg->offset);
    fprintf(output_file,"1st Codon : %d\n",cur_seg->first_codon_choice);
    fprintf(output_file,"%s\n",amino_buffer);
    fprintf(output_file,"%s\n",cur_seg->dna_data);
    fprintf(output_file,"\n");
    cur_seg = cur_seg->next_seg;
}

/* Write out segment names in scrambled order */
fprintf(output_file,"Segments in scrambled order:\n");
fprintf(output_file,"-----\n");
for (i=0;i<num_segments;i++) {
    /* Format amino data to line up with codons */
    pad_amino_string(scrambled_segments[i]->amino_data,amino_buffer);
    /* Write segment details */
    fprintf(output_file,"%s #%d\n",scrambled_segments[i]->p_gene->name,
        scrambled_segments[i]->number);
    fprintf(output_file,"%s\n",amino_buffer);
    fprintf(output_file,"%s\n",scrambled_segments[i]->dna_data);
    fprintf(output_file,"\n");
}

```

Figure 25 (Cont)

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```

    }

    /* Write synthetic protein in one long string */
    fprintf(output_file, "Synthetic Protein:\n");
    fprintf(output_file, "-----\n");
    for (i=0; i<num_segments; i++)
        fprintf(output_file, "%s", scrambled_segments[i]->amino_data);

    fprintf(output_file, "\n\n");

    /* Write synthetic dna in one long string */
    fprintf(output_file, "Synthetic DNA:\n");
    fprintf(output_file, "-----\n");
    for (i=0; i<num_segments; i++)
        fprintf(output_file, "%s", scrambled_segments[i]->dna_data);

    return E_NOERROR;
}

/* strip_newline() */
/* Replace the first newline character with a null */
void strip_newline(char * strip_str) {
    char * newline_pos;

    /* Find the newline char */
    newline_pos = strchr(strip_str, '\n');

    /* If we found one, replace it with a null */
    if (NULL != newline_pos)
        newline_pos[0] = '\0';
}

/* pad_amino_string */
/* Copy amino chars from amino_ptr to padded_ptr, padding each */
/* side with a space. */
void pad_amino_string(char * amino_ptr, char * padded_ptr) {
    while ('\0' != *amino_ptr) {
        *padded_ptr = ' ';
        padded_ptr++;
        *padded_ptr = *amino_ptr;
        padded_ptr++;
        *padded_ptr = ' ';
        padded_ptr++;
        amino_ptr++;
    }

    /* Stick a null at the end of the padded string */
    *padded_ptr = '\0';
}

/* even() */
/* True if test_num is even, otherwise false */

```

Figure 25 (Cont)

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```

int even(int test_num) {
    return !(test_num % 2);
}

/* read_int() */
/* Read an integer from stdin. Keep trying until valid int > 0 entered. */
/* Return the integer read, or 0 if error reading from stdin. */

int read_int(char * prompt) {
    char buffer[KEYBOARD_BUFFER_SIZE];
    int value_read;
    int valid = FALSE;

    while (!valid) {
        printf("%s", prompt);
        valid = TRUE;
        fgets(buffer, KEYBOARD_BUFFER_SIZE, stdin);
        if (1 != sscanf(buffer, "%d", &value_read))
            valid = FALSE;
        if (valid && (value_read < 1))
            valid = FALSE;
        if (!valid)
            printf("Positive integer value please!\n");
    }

    return value_read;
}

/* read_str() */
/* Read a string from the user (stdin) */
/* Strip the newline from it */

void read_str(char * prompt, char * string) {
    char buffer[KEYBOARD_BUFFER_SIZE];

    printf(prompt);
    fgets(buffer, KEYBOARD_BUFFER_SIZE, stdin);
    sscanf(buffer, "%s", string);
}

/* read_nonblank_line() */
/* Read a line from file until we get a non-blank one */

char * read_nonblank_line(char * buf, int buf_size, FILE * in_file) {
    char * return_ptr;

    /* Read lines until we get a non-blank one, or EOF */
    do
        return_ptr = fgets(buf, buf_size, in_file);
    while ((NULL != return_ptr) && ((' ' == buf[0]) || ('\n' == buf[0]]));

    /* If we got a line, change the newline char to a null */
    if (NULL != return_ptr)
        strip_newline(buf);
}

```

Figure 25 (Cont)

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```
        return return_ptr;
    }

/* user_confirmation() */
/* Read input from user. If user types 'y', return 1, otherwise 0 */
int user_confirmation() {
    char buffer[KEYBOARD_BUFFER_SIZE];

    fgets(buffer,KEYBOARD_BUFFER_SIZE,stdin);
    if (('y' == buffer[0]) || ('Y' == buffer[0]))
        return 1;
    else
        return 0;
}

/* test() */
/* For debugging/development */
void test() {
    char str[100];
    printf("Enter something: ");
    fgets(str,100,stdin);
    printf("line1\n");
    printf("%s",str);
    printf("line2\n");
    fgets(str,100,stdin);
}
```

Figure 25 (Cont)

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HepC Savine d sign

HepC 1a consensus polyprotein sequence used for scramble program

MSTNPKPQRKTKRNTNRRPQDVKFPGGGQIVGGVYLLPRRGPRLGVRATRKTSERSQPRGRRQPIPKARRPEGRTHWAQ
 PGYPWPPLYGNEGCGWAGWLLSPRGSRPSWGPTDPRRRSRNLGKVIDTLTCGFADLMGYIPLVGAPLGGAAARALAHGVR
 VLEDGVNYATGNLPGCSFSIFLLALLSCLTVPASAYQVRNSTGLYHVTNDCPNSSIVYEADAILHTPGCVPCVREGN
 ASRCWVAMTPTVATRDGKLPATQLRRHIDLVLGSATLCSALYVGDLCGSVFLVGQLFTFSPRRHWTQGCNCSIYPGH
 ITGHRMAWDMMMNWSPTAALVMAQLLRIPQAILDMIAGAHWGVLGAIYFSMVGNWAKVLVLLLFAGVDAETHVTGG
 NAGRITSGLVSLTTPGAKQNIQLINTNGSWHINSTALNCNESLNTGWLAGLFYQHKFNSSGCPERLASCRRLTDFDQG
 WGPISYANGSGPDQRPYCWHPKPCGIVPAKSVCGPVYCFTFSPVVVGTTDRSGAPTYSWGANDTDVFLNNTRPPL
 GNWFGCTWMNSTGFTKVCGAPPVIGGAGNNTLHCPDTCFRKHPEATYSRCGSGPWITPRCLVDYIPYRLWHYPCTINY
 TIFKVRMYVGGVEHRLEAACNWTGRERCLEDRDRSELSPLLLSTTQWQVLPSCSFTTLPALSTGLIHLHQNIVDVQYL
 YGVGSSIASWAIKWEYVLLFLLADARVCSCLWMLLISQAEAALENLVILNAASLAGTHGLVSFLVFPFPAWYKLG
 RWVPGAVYALYGMWPLLLLLLALPQRAYALDTEVAASCGGVVLVGLMALTLSPYYKRYISWCLWWLQYFLTRVEAQLH
 VWVPLNVRGGRDAVILLMCVVHPTLVFDITKLLAVFGPLWILQASLLKVPYFVRVQGLLRICALARKMIGGHYVQM
 AIIKLGALTGTYYVNHLPRLDWAHNGLRDLAVAVEPVVFSQMETKLITWGADTAACGDIINGLPVSARRGREILLGP
 ADGMVSKGWRLLAPITAYAQQTRGLLGCIIITSLTGRDKNQVEGEVQIVSTAAQTFLATCINGVCWTVYHGAGTRTIIAS
 PKGPVIQMYTNDQDLVGWPAPOGSRSLTPTCTCGSSDLYLVTRHADVIPVRRRGDSRGSLLSRPISYLGSSGGPPLL
 CPAGHAVGIFRAAVCTRGVAKAVDFIPVENLETTMRSPVFTDNSSPPAVPQSFQVAHLHAPTGSGLSTKVPAAAYAAQG
 YKVLVLNPSVAATLPGAYMSKAHGIDPNIRTGVRTITGSPITYSTYKFLADGGCSGGAYDIIICDECHSTZATS I
 LGIGTVLDQAETAGARLVVLATATPPGSVTVPHPNIBEVALSTTGEIPFYGKAIPLEVIKGRHLIFCHSKKKCDELA
 AKLVALGINAVAYYRGLDVSVIPTSGDVVVVATDALMTGYTGDGDFSDICNTCVTQTVDPSLDPTFTTETTLTPQDAV
 SRTQRRGRTGRGKPGIYRFVAPGERPSGMFDSSVLCECYDAGCAWYELTPAETTIVLRAYMNTGGLPVCQDHLFEWEG
 VFTGLTHIDAHFLSQTKQSGENFPYLVAYQATVCARAQAPPPSWDQMWKCLIRLKP TLHGPTPLLYRLGAVQNEVTLT
 HPVTKYIMTCSADLEVVTTSTWVLVGGVLAALAAAYCLSTGCVVIVGRIVLSGKPAIPDREVLYREFDEMEECSQLP
 YIEQGMMLAEQFKQKALGLLQTASRQAEVIAPAVQTNWQKLEVFWAKHMMWNFISGIQYLAGLSTLPGNPAIASLMAFT
 AAVTSPLTTSQTLFNLGGWVAAQLAAPGAATAFVAGLAGAAIGSVGLGKVLVDILAGYGAGVAGALVAFKIMSGE
 VPSTEDLVNLLPAILSPGALVVGVCVCAAILRRHVGPGEAGVQWMNRLIAPASRGNHVSPTHYVPESDAAARVTAI LSS
 LTVQQLRLRLHQWISSECTTPCSGSLWRDIWDWICEVLSDFKTWKLAKLMPQLPGIPFVSCQRGYKGVWRGDGIMHTR
 CHCGAEITGHVKNGTMRIVGPRTCRNMWSGTFPINA YTTGCPCTPLPAPNYTFALWRVSAEYVEIRRVGDFHYVTGMT
 TDNLKCPQVPSPEFFTELDGVR LHRFAPPCKPLLRKEVSFRVGLHEYPVGSQLPCEPEPDVAVLTSMLTDP SHITAE
 AAGRRRLARGSPPSMASSASQLSAPSLKATCTANHDSFDAELIEANLLWRQEMGNI TRVESENKVVLDSFDPLVAE
 EDEREISVPAIILKRSRRFAQALPVWARPDYNPPLVETWKKPDYEPVHVHGCPLPPPRSPVPPPRKRTVVLTSTL
 STALAKLATKSPGSSSTSGITGDNITTSSEPAPSGCPPDSDASYSMPPLEGEPGDPDLSDGSWSTVSSEAGTEDVV
 CCSMSYSWTGALVTPCAAEEQKLPINALSNSLLRHHNLVYSTTSRSACQRQKVTFDRLQVLDSHYQDVLKEVKAAAS
 KVKANLLSVERACSLTPPHSAKSKFGYGAKDVRCHARKAVAHINSVWKD LLED SVTPIDTTIMAKNEVFVCPQPEKGR
 KPARLIVFPDLGVRVCEKMALYDVVSKLPLAVMGSSYGFQYSPQRVEFLVQAWKSKKTPMGFSYDTRCFDSTVTESD
 IRTEBAIYQCDLDPQARVAIKSLTERLYVGGPLTNSRGENCGYRRCRASGLVLTSCGNLTLCYIKARAACRAAGLQD
 CTMLVCGDDLVLVICESAGVQEDAASLRAFTRAMTRYAPPDPPQPEYDLELITSCSSNVSVAHGDGAGKRVYYLTRDP
 TTPLARAAMETARHTPVNSWLGNII MFAPTLWARMILMTHFPVSVLIARDQLEQALDCEIYGACYSIEPLDLPPIIQRL
 HGLSAPSLHSYSPGEINRVAACLRLKLGVPPLRAWHRARSVRARLLARGGRAAICGKYLFNWA VRTKLKLTPIAAAGR
 LDLSGWFTAGYSGGDIYHSVSHARPRWFWFCLLLLAAGVGIYLLPNR

Scramble - Output File

Scramble version : 0.1 beta, 08/02/1999

Num. genes : 1
 Num. segments : 201
 Segment length : 30
 Segment overlap : 15

Segments in original order:

 Gene : HepC1a
 Segment# : 1
 Offset : 1
 1st Codon : 1

A A M S T N P K P Q R K T K R N T N R R P Q D V K F P G G G
 GCCGCTATGTCCACCAATCCCAAAACCCAAAGGAAAACCAAAAGGAATACCAATAGGAGACCCCAAGACGTCAAGTTTCCCGGAGCGGA

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Gene : HepCla
Segment# : 2
Offset : 16
1st Codon : 1
N T N R R P Q D V K F P G G G Q I V G G V Y L L P R R G P R
AACACAAACAGAGGCCCTCAGGATGTGAAATTCCTGGCGGAGGCCAAATCGTCGGCGGAGTGATCTGCTCCCCAGAAGGGGACCCAGA

Gene : HepCla
Segment# : 3
Offset : 31
1st Codon : 1
Q I V G G V Y L L P R R G P R L G V R A T R K T S E R S Q P
CAGATTGTGGGAGCGCTACCTCCTGCCTAGGAGAGGCCCTAGGCTCGGCGTCAGGGCTACCAGAAAGACAAGCGAAAGGTCCCAGCCT

Gene : HepCla
Segment# : 4
Offset : 46
1st Codon : 1
L G V R A T R K T S E R S Q P R G R R Q P I P K A R R P E G
CTGGGAGTGAGAGCCACAAGGAAAACCTCCGAGAGAAGCCAACCCAGAGGCAGAAGGCAACCCATTCCCAAAGCCAGAAGGCTGAGGGA

Gene : HepCla
Segment# : 5
Offset : 61
1st Codon : 1
R G R R Q P I P K A R R P E G R T W A Q P G Y P W P L Y G N
AGGGGAAGGAGACAGCCTATCCCTAAGGCTAGAGACCCGAAGGCAGAACCTGGGCCCAACCCGATACCTTGGCCTCTGTATGGCAAT

Gene : HepCla
Segment# : 6
Offset : 76
1st Codon : 1
R T W A Q P G Y P W P L Y G N E G C G W A G W L L S P R G S
AGGACATGGGCTCAGCCTGGCTATCCCTGGCCCCCTCTACGGAAACGAAGGCTGTGGCTGGGCCGGATGGCTCCTGTCCCCAGAGGCTCC

Gene : HepCla
Segment# : 7
Offset : 91
1st Codon : 1
E G C G W A G W L L S P R G S R P S W G P T D P R R R S R N
GAGGGATGGGATGGGCTGGCTGGCTCAGCCTAGGGGAAGCAGACCTCCTGGGGACCCACAGACCTAGGAGAAGGTCCAGGAAT

Gene : HepCla
Segment# : 8
Offset : 106
1st Codon : 1
R P S W G P T D P R R R S R N L G K V I D T L T C G F A D L
AGGCCTAGCTGGGGCCTACCGATCCAGAGGAGAGCAGAAACCTCGGCAAGTGATTGACACACTGACATCGGATTGCTGACCTC

Gene : HepCla
Segment# : 9
Offset : 121
1st Codon : 1
L G K V I D T L T C G F A D L M G Y I P L V G A P L G G A A
CTGGGAAAGGTATGATACCTCCTCAGCTTGGCTTTGCCGATCTGATGGGCTATATCCCTCTGGTCGGCGCTCCCTCGGCGGAGCCGCT

Gene : HepCla
Segment# : 10
Offset : 136
1st Codon : 1
M G Y I P L V G A P L G G A A R A L A H G V R V L E D G V N
ATGGGATACATTCCCTCGTGGGAGCCCCCTCTGGGAGGCGCTGCCAGAGCCCTCGCCCATGGCGTCAGGGTCCTGGAAGACGGAGTGAAT

Gene : HepCla
Segment# : 11
Offset : 151
1st Codon : 1
R A L A H G V R V L E D G V N Y A T G N L P G C S P S I P L
AGGGCTCTGGCTCAGGAGTGAGAGTGCTCGAGGATGGCGTCAACTATGCCACAGGCAATCTGCCCTGGCTGTAGCTTTAGCATTTCTCTC

Gene : HepCla
Segment# : 12
Offset : 166

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1st Codon : 1
Y A T G N L P G C S F S I F L L A L L S C L T V P A S A Y Q
TACGCTACCGGAACCTCCCGGATGCTCCTTCTCCATCTTTCTGCTCGCCCTCCTGTCTGCTCACCCTCCCGCTAGCGCTTACCAA

Gene : HepCla
Segment# : 13
Offset : 181
1st Codon : 1
L A L L S C L T V P A S A Y Q V R N S T G L Y H V T N D C P
CTGGCTCTGCTCAGCTGTCTGACAGTGCCTGCCTCCGCCTATCAGGTGAGGAATAGCACAGGCCTCTACCATGTGACAAACGATTGCCCT

Gene : HepCla
Segment# : 14
Offset : 196
1st Codon : 1
V R N S T G L Y H V T N D C P N S S I V Y E A A D A I L H T
GTGAGAACTCCACCGACTGTATCAGTCCACCAATGACTGTCCCAATAGCTCCATCGTCTACGAAGCGCTGACGCTATCTCCACACA

Gene : HepCla
Segment# : 15
Offset : 211
1st Codon : 1
N S S I V Y E A A D A I L H T P G C V P C V R E G N A S R C
AACTCCAGCATTTGTATGAGGCTGCCGATGCCATTTCTGCATACCCCTGGCTGTGTGCCCTTGCGTCAGGGAAGGCAATGCCCTCCAGGTGT

Gene : HepCla
Segment# : 16
Offset : 226
1st Codon : 1
P G C V P C V R E G N A S R C W V A M T P T V A T R D G K L
CCCGATGCGTCCCTGTGTGAGAGAGGGAACGCTAGCAGATGCTGGGTGGCTATGACACCCAAGTGGCTACCAGAGACGGAAAGCTC

Gene : HepCla
Segment# : 17
Offset : 241
1st Codon : 1
W V A M T P T V A T R D G K L P A T Q L R R H I D L L V G S
TGGTTCGCGATGACCCCTACCGTGGCCAGGGATGGCAACTGCTGCCACACAGCTCAGGAGACACATTGACCTCCTGGTGGCTCGT

Gene : HepCla
Segment# : 18
Offset : 256
1st Codon : 1
P A T Q L R R H I D L L V G S A T L C S A L Y V G D L C G S
CCCGTACCCAACTGAGAAGGCATATGATCTGCTCGTGGGAAGCGCTACCCCTCTGCTCCGCCCTCTAGTCCGGGATCTGTGTGGCTCC

Gene : HepCla
Segment# : 19
Offset : 271
1st Codon : 1
A T L C S A L Y V G D L C G S V F L V G Q L F T F S P R R H
GCCACACTGTGTAGCGCTCTGTATGTGGGAGACCTCTGCGGAAGCGTCTTCTCGTGGGACAGCTCTTCACATTCTCCCCCAGAAGGCAT

Gene : HepCla
Segment# : 20
Offset : 286
1st Codon : 1
V F L V G Q L F T F S P R R H W T T Q G C N C S I Y P G H I
GTGTTTCTGGTCCGCCAACTGTTTACCTTTAGCCCTAGGAGACACTGGACCAACAGGGATGCAATTGCTCCATCTATCCCGGACACATT

Gene : HepCla
Segment# : 21
Offset : 301
1st Codon : 1
W T T Q G C N C S I Y P G H I T G H R M A W D M M M N W S P
TGGACACCCAAGGCTGTAACCTGTAGCATTACCTGGCCATATCACAGGCCATAGGATGGCCTGGGACATGATGATGAACCTGGAGCCCT

Gene : HepCla
Segment# : 22
Offset : 316
1st Codon : 1
T G H R M A W D M M M N W S P T A A L V M A Q L L R I P Q A
ACCGGACACAGAATGGCTTGGGATATGATGATGAATTGGTCCCCCAGCCGCTCTGGTCAATGGCTCAGCTCCTGAGAATCCCTCAGGCT

Figure 26 (Cont)

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Gene : HepCla
Segment# : 23
Offset : 331
1st Codon : 1
T A A L V M A Q L L R I P Q A I L D M I A G A H W G V L A G
ACCGCTGCCCTCGTATGGCCAACTGCTCAGGATTCCCAAGCCATTCTGGATATGATTGCCGAGCCCATGGGGAGTGTCTGCCGGA

Gene : HepCla
Segment# : 24
Offset : 346
1st Codon : 1
I L D M I A G A H W G V L A G I A Y P S M V G N W A K V L V
ATCTCGACATGATCGCTGGGGCTCACTGGGGCGTCTGGCTGGCATTGCCTATTCTCCATGGTCGGCAATTGGGCTAAGGTCTGGTC

Gene : HepCla
Segment# : 25
Offset : 361
1st Codon : 1
I A Y P S M V G N W A K V L V V L L L F A G V D A E T H V T
ATCGCTTACTTTAGCATGGTGGGAACTGGGCCAAAGTGCTCGTGGTCTGCTCTCTGTTGCGGAGTGGATGCCGAAACCATGTGACA

Gene : HepCla
Segment# : 26
Offset : 376
1st Codon : 1
V L L L F A G V D A E T H V T G G N A G R T T S G L V S L L
GTGCTCTGCTCTTCTGGCTGGAGCTGAGACACACGTCACCGGAGGCAATGCCGGAAGGACAACCTCCGGCTGTGTCTCTGCTC

Gene : HepCla
Segment# : 27
Offset : 391
1st Codon : 1
G G N A G R T T S G L V S L L T P G A K Q N I Q L I N T N G
GGCGAAACGCTGGCAGAACCACAAGCGGACTGGTCAGCCTCCTGACACCCGAGCCAAACAGAATATCCAAGTATTAAACAAACGGA

Gene : HepCla
Segment# : 28
Offset : 406
1st Codon : 1
T P G A K Q N I Q L I N T N G S W H I N S T A L N C N E S L
ACCCCTGGCGCTAAGCAAAACATTGAGCTCATCAATACCAATGGCTCCTGGCATATCAATAGCACAGCCTCAACTGTAAACGAAAGCCTC

Gene : HepCla
Segment# : 29
Offset : 421
1st Codon : 1
S W H I N S T A L N C N E S L N T G W L A G L F Y Q H K F N
AGCTGGCACATTAATCCACGCTCTGAATTGCAATGAGTCCCTGAATACCGGATGGCTGCCCGACTGTTTTACCAACACAAAATCAAT

Gene : HepCla
Segment# : 30
Offset : 436
1st Codon : 1
N T G W L A G L F Y Q H K F N S S G C P E R L A S C R R L T
AACACAGGCTGGCTGGCTGGCTCTTCTATCAGCATAAGTTTAACTCCAGGGATGCCCTGAGAGACTGGCTAGCTGTAGGAGACTGACA

Gene : HepCla
Segment# : 31
Offset : 451
1st Codon : 1
S S G C P E R L A S C R R L T D F D Q G W G P I S Y A N G S
AGCTCCGGCTGTCCGAAAGGCTCGCCTCCTGCAGAAGGCTCACCGATTTCGATCAGGGATGGGGACCCATTAGCTATGCCAATGGCTCC

Gene : HepCla
Segment# : 32
Offset : 466
1st Codon : 1
D F D Q G W G P I S Y A N G S G P D Q R P Y C W H Y P P K P
GACTTTGACCAAGGCTGGGGCCCTATCTCTACGCTAACGGAAGCGGACCCGATCAGAGACCCTATTGCTGGCACTATCCCCCTAAGCCT

Gene : HepCla
Segment# : 33

Figure 26 (Cont)

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Offset : 481
1st Codon : 1
G P D Q R P Y C W H Y P P K P C G I V P A K S V C G P V Y C
GGCCCTGACCAAAGGCCTTACTGTGGCATTACCCCTCCCAAACCTGTGGCATTGTGCCTGCCAAAAGCGTCTGCGGACCCGTCTACTGT

Gene : HepC1a
Segment# : 34
Offset : 496
1st Codon : 1
C G I V P A K S V C G P V Y C F T P S P V V V G T T D R S G
TGGGAATCGTCCCGCTAAGTCCGTGTGTGGCCCTGTGTATTGCTTTACCCCTAGCCCTGTGGTCGTGGGAACCAAGACAGAGAAGCGGA

Gene : HepC1a
Segment# : 35
Offset : 511
1st Codon : 1
F T P S P V V V G T T D R S G A P T Y S W G A N D T D V F V
TTCACACCTCCCGCTCGTGGTCGGCACAACCGATAGGTCCGGCGCTCCACATACTCCTGGGGAGCCAATGACACAGACGCTCTCGTG

Gene : HepC1a
Segment# : 36
Offset : 526
1st Codon : 1
A P T Y S W G A N D T D V F V L N N T R P P L G N W F G C T
GCCCTACCTATAGCTGGGGCGCTAACGATACCGATGTGTATTGTGCTCAACATACAGACCCCTCTGGGAACTGGTTCCGATGCACA

Gene : HepC1a
Segment# : 37
Offset : 541
1st Codon : 1
L N N T R P P L G N W F G C T W M N S T G F T K V C G A P P
CTGAATAACACAAGGCCTCCCGTGGCAATTGGTTTGGCTGTACCTGGATGAATAGCACAGGCTTTACCAAAGTGTGTGGCGCTCCCGCT

Gene : HepC1a
Segment# : 38
Offset : 556
1st Codon : 1
W M N S T G F T K V C G A P P C V I G G A G N N T L H C P T
TGGATGAATCCACGGATTTCACAAAGGTCTGCGGAGCCCTCCCTGTGTGATTGGCGGAGCCGGAAACAATACCTCCACTGTCCACA

Gene : HepC1a
Segment# : 39
Offset : 571
1st Codon : 1
C V I G G A G N N T L H C P T D C F R K H P E A T Y S R C G
TGGTCATCGGAGGCGCTGGCAATAACACACTGCATTGCCCTACCGATTGCTTTAGGAAACACCTGAGGCTACCTATAGCAGATGCGGA

Gene : HepC1a
Segment# : 40
Offset : 586
1st Codon : 1
D C F R K H P E A T Y S R C G S G P W I T P R C L V D Y P Y
GACTGTTTCAGAAAGCATCCCGAAGCCATACCTCCAGGTGTGCTCCGGCCCTGGATTACCCCTAGGTGTCTGGTCGACTATCCCTAT

Gene : HepC1a
Segment# : 41
Offset : 601
1st Codon : 1
S G P W I T P R C L V D Y P Y R L W H Y P C T I N Y T I F K
AGCGGACCTGGATCACACCCAGATGCCCTCGTGGATTACCCCTACAGACTGTGGCACTATCCCTGTACCATTAACTATACCATTTTCAAA

Gene : HepC1a
Segment# : 42
Offset : 616
1st Codon : 1
R L W H Y P C T I N Y T I F K V R M Y V G G V E H R L E A A
AGGCTCTGGCATTACCCCTTGACAATCAATTACACAATCTTTAAGGTGAGGATGACGTGGCGGAGTGGAAACACAGACTGGAAGCCGCT

Gene : HepC1a
Segment# : 43
Offset : 631
1st Codon : 1
V R M Y V G G V E H R L E A A C N W T R G E R C D L E D R D

Figure 26 (Cont)

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GTGAGAATGTATGTGGGAGGCGTCGAGCATAGGCTCGAGGCTGCCTGTAAGTGGACCAGAGGCGAAAGGTGTGACCTCGAGGATAGGGAT

Gene : HepCla

Segment# : 44

Offset : 646

1st Codon : 1

C N W T R G E R C D L E D R D R S E L S P L L L S T T Q W Q
TGCAATTGGACAGGGGAGAGAGATGCGATCTGGAAGACAGAGACAGAAGCGAACTGTCCCCCTCCTGCTCAGCACAAACCAATGGCAA

Gene : HepCla

Segment# : 45

Offset : 661

1st Codon : 1

R S E L S P L L L S T T Q W Q V L P C S F T T L P A L S T G
AGGTCGAGCTCAGCCCTCTGCTCCTGTCCACCACACAGTGGCAGGTCTGCTCTTCAACCCCTCCCGCTCTGTCCACCGGA

Gene : HepCla

Segment# : 46

Offset : 676

1st Codon : 1

V L P C S F T T L P A L S T G L I H L H Q N I V D V Q Y L Y
GGCTCCCCGTAGCTTTACCACTGCCTGCCCTCAGCACAGGCCTCATCCATCTGCATCAGAATATCGTCGACGTCAGGTATCTGTAT

Gene : HepCla

Segment# : 47

Offset : 691

1st Codon : 1

L I H L H Q N I V D V Q Y L Y G V G S S I A S W A I K W E Y
CTGATTCACCTCCACAAAACATTGTGGATGTGCAATACCTCTACGGAGTGGGAAGCTCCATCGCTAGCTGGGCCATTAGTGGGAGTAT

Gene : HepCla

Segment# : 48

Offset : 706

1st Codon : 1

G V G S S I A S W A I K W E Y V V L L F L L L A D A R V C S
GGCTGGCTCCAGCATTCCTCCTGGGTATCAATGGGAATACGTGCTGCTCTGTTCTGCTCCTGGCTGACGCTAGGGTCTGCTCC

Gene : HepCla

Segment# : 49

Offset : 721

1st Codon : 1

V V L L F L L L A D A R V C S C L W M M L L I S Q A E A A L
GTGGTCTGCTCTTCTCCTGCTGCGGATGCCAGTGTGTAGCTGTCTGTGGATGATGCTGCTCATCTCCAGGCTGAGGCTGCCCTC

Gene : HepCla

Segment# : 50

Offset : 736

1st Codon : 1

C L W M M L L I S Q A E A A L E N L V I L N A A S L A G T H
TGCTCTGGATGATGCTCCTGATTAGCCAAGCGAAGCGCTCTGGAAGAACTCGTGATTCTGAATGCCGCTAGCCTCGCGGAACCCAT

Gene : HepCla

Segment# : 51

Offset : 751

1st Codon : 1

E N L V I L N A A S L A G T H G L V S F L V F F C F A W Y L
GAGAATCTGGTCATCTCAACGCTGCCTCCCTGGCTGGCACACGGACTGGTCAGCTTTCTGGTCTTCTTTGCTTTGCCTGGTACCTC

Gene : HepCla

Segment# : 52

Offset : 766

1st Codon : 1

G L V S F L V F F C F A W Y L K G R W V P G A V Y A L Y G M
GGCTCTGTCCTTCCTCGTGTTTTCTGTTTGGCTTGGTATCTGAAAGCAGATGGGTCCCGGAGCCGTCTACGCTCTGTATGGCATG

Gene : HepCla

Segment# : 53

Offset : 781

1st Codon : 1

K G R W V P A V Y A L Y G M W P L L L L L L A L P Q R A Y
AAGGAAGGTGGGTGCCTGGCGCTGTGTATGCCCTCTACGGAATGTGGCCCTCCTGCTCCTGCTCTGGCTCTGCCTCAGAGAGCCTAT

Gene : HepCla

Figure 26 (Cont)

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Segment# : 54
Offset : 796
1st Codon : 1
W P L L L L L L A L P Q R A Y A L D T E V A A S C G G V V L
TGGCCTCTGCTCCTGCTCGCCCTCCCCCAAAGGGCTTACGCTCTGGATACCGAAGTGGCTGCCTCCTGCGGAGGCGTGTGCTC

Gene : HepC1a
Segment# : 55
Offset : 811
1st Codon : 1
A L D T E V A A S C G G V V L V G L M A L T L S P Y Y K R Y
GCCCTCGACACAGAGTCCGCGCTAGCTGTGGCGGAGTGGTCTGTGGCCCTCATGGCTCTGACACTGTCCCCCTATTACAAAAGGTAT

Gene : HepC1a
Segment# : 56
Offset : 826
1st Codon : 1
V G L M A L T L S P Y Y K R Y I S W C L W W L Q Y F L T R V
GTGGGACTGATGGCCCTCAGCCCTACTATAAGAGATACATTAGCTGGTGCCTCTGGTGGCTGCAATACTTTCTGACAAGGGTC

Gene : HepC1a
Segment# : 57
Offset : 841
1st Codon : 1
I S W C L W W L Q Y F L T R V E A Q L H V W V P P L N V R G
ATCTCTGGTGTCTGTGGTGGCTCCAGTATTTCTCACCAGAGTGAAGCCCAACTGCATGTGTGGGTGCCTCCCTCAACGTCAGGGGA

Gene : HepC1a
Segment# : 58
Offset : 856
1st Codon : 1
E A Q L H V W V P P L N V R G G R D A V I L L M C V V H P T
GAGGCTCAGCTCCAGCTCTGGGTCCCCCTCTGAATGTGAGAGGGGAAGGGATGCGCTCATCTCTGATGTGCGTGTGTCATCCACA

Gene : HepC1a
Segment# : 59
Offset : 871
1st Codon : 1
G R D A V I L L M C V V H P T L V F D I T K L L L A V F G P
GGCAGAGACGCTGTGATTCTGCTCATGTGTGTGGTCCACCTACCCCTCGTGTGTTGACATTACCAAACCTGCTCTGGCTGTGTTGGCCCT

Gene : HepC1a
Segment# : 60
Offset : 886
1st Codon : 1
L V F D I T K L L L A V F G P L N I L Q A S L L K V P Y F V
CTGTCTTCGATATCAAAAGCTCTGCTCGCGCTCTCGGACCCCTCTGGATTCTGCAAGCCTCCCTGCTCAAGGTCCCTATTTCGTC

Gene : HepC1a
Segment# : 61
Offset : 901
1st Codon : 1
L W I L Q A S L L K V P Y F V R V Q G L L R I C A L A R K M
CTGTGGATCCTCCAGGCTAGCCTCCTGAAAGTGCTTACTTTGTGAGAGTGCAAGGCCTCCTGAGAATCTGTGCCCTCGCCAGAAAGATG

Gene : HepC1a
Segment# : 62
Offset : 916
1st Codon : 1
R V Q G L L R I C A L A R K M I G G H Y V Q M A I I K L G A
AGGTCACAGGACTGCTCAGGATTTGCGCTCTGGCTAGGAAAATGATTGCGGACACTATGTGCAATGGCTATCATTAAAGCTCGGCGCT

Gene : HepC1a
Segment# : 63
Offset : 931
1st Codon : 1
I G G H Y V Q M A I I K L G A L T G T Y V Y N H L T P L R D
ATCGGAGGCCATTACGTCCAGATGGCCATTATCAAACCTGGGAGCCCTACCGGAACCTATGTGTATAACCATCTGACACCCCTCAGGGAT

Gene : HepC1a
Segment# : 64
Offset : 946
1st Codon : 1

Figure 26 (Cont)

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L T G T Y V Y N H L T P L R D W A H N G L R D L A V A V E P
CTGACAGGCACATACGTCTACATCACCTCACCCCTCTGAGAGACTGGGCCCATAAACGAGCTGAGAGACCTCGCCGTCGCCGTCGAGCGCT

Gene : HepC1a

Segment# : 65

Offset : 961

1st Codon : 1

W A H N G L R D L A V A V E P V V F S Q M E T K L I T W G A
TGGGCTCACAAATGGCCTCAGGATCTGGCTGTGGCTGTGGAACCCGTCGTGTTTAGCCAAATGGAAACCAAACTGATTACCTGGGGCGCT

Gene : HepC1a

Segment# : 66

Offset : 976

1st Codon : 1

V V F S Q M E T K L I T W G A D T A A C G D I I N G L P V S
GTGGTCTTCTCCAGATGGAGACAAAGCTCATCATGCGGAGCCGATACCGCTGCCGTGTGGCGATATCATTAAACGAGCTGCCGTGTGTCC

Gene : HepC1a

Segment# : 67

Offset : 991

1st Codon : 1

D T A A C G D I I N G L P V S A R R G R E I L L G P A D G M
GACACAGCCCTTGGGAGACATTATCAATGGCCTCCCGTCAGCGCTAGGAGAGGCAGAGAGATTCTGCTCGGCCCTGCCGATGGCATG

Gene : HepC1a

Segment# : 68

Offset : 1006

1st Codon : 1

A R R G R E I L L G P A D G M V S K G W R L L A P I T A Y A
GCCAGAAGGGGAAGGGAATCCTCTGGGACCCGCTGACGGAATGGTCAGCAAAGGCTGGAGGCTCCTGGCTCCCATACCGCTTACGCT

Gene : HepC1a

Segment# : 69

Offset : 1021

1st Codon : 1

V S K G W R L L A P I T A Y A Q Q T R G L L G C I I T S L T
GTGTCAAGGGATGGAGACTGCTGCGCCCTATCACAGCCTATGCCCAACAGACAAGGGGACTGCTCGGCTGTATCATTACCTCCCTGCACA

Gene : HepC1a

Segment# : 70

Offset : 1036

1st Codon : 1

Q Q T R G L L G C I I T S L T G R D K N Q V E G E V Q I V S
CAGCAAACAGAGGCTCCTGGGATGCATTATCACAGCCTCACCGGAAGGATAAGAATCAGGTCGAGGAGAGGTCCAGATTGTGTCC

Gene : HepC1a

Segment# : 71

Offset : 1051

1st Codon : 1

G R D K N Q V E G E V Q I V S T A A Q T F L A T C I N G V C
GGCAGAGACAAAACCAAGTGAAGGCGAAGTGCAATCGTCAGCAGCCGCTCAGACATTCTCGCCACATGCATTAAACGAGTGTGT

Gene : HepC1a

Segment# : 72

Offset : 1066

1st Codon : 1

T A A Q T F L A T C I N G V C N T V Y H G A G T R T I A S P
ACCGTGCCTCAACCTTTCTGGTACCTGTATCAATGGCGTCTGCTGGACCGTCTACCTGGCGCTGGCACAAAGGACAATCGCTAGCCCT

Gene : HepC1a

Segment# : 73

Offset : 1081

1st Codon : 1

W T V Y H G A G T R T I A S P K G P V I Q M Y T N V D Q D L
TGGACAGTGTATCAGGAGCCCGAACCAGAACCATTCCTCCCCAAAGGCCCTGTGATTGAGATGTACACAAACGTCGACCAAGACCTC

Gene : HepC1a

Segment# : 74

Offset : 1096

1st Codon : 1

K G P V I Q M Y T N V D Q D L V G W P A P Q G S R S L T P C
AAGGAGCCCGTCATCCAAATGTATACCAATGTGGATCAGGATCTGGTGGCGCTGGCCCGCTCCCCAAGGCTCCAGGTCCCTGACACCCCTGT

Figure 26 (Cont)

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Gene : HepCla
Segment# : 75
Offset : 1111
1st Codon : 1
V G W P A P Q G S R S L T P C T C G S S D L Y L V T R H A D
GTGGATGGCTGCCCCTCAGGGAAGCAGAAGCCTCACCCCTTGCACATGCGGAAGCTCCGACCTCTACCTCGTGACAAGGCATGCCGAT

Gene : HepCla
Segment# : 76
Offset : 1126
1st Codon : 1
T C G S S D L Y L V T R H A D V I P V R R R R G D S R G S L L
ACCTGTGGCTCCAGCGATCTGTATCTGGTCACCAGACACGCTGACGTCATCCCTGTGAGAAGGAGAGGGCGATAGCAGAGGCTCCCTGCTC

Gene : HepCla
Segment# : 77
Offset : 1141
1st Codon : 1
V I P V R R R R G D S R G S L L S P R P I S Y L K G S S G G P
GTGATTCCCGTCCAGGAGAAGGGGAGACTCCAGGGGAAGCCTCCTGTCCCCCAGACCCATTAGCTATCTGAAAGGCTCCAGCGGAGGCCCT

Gene : HepCla
Segment# : 78
Offset : 1156
1st Codon : 1
S P R P I S Y L K G S S G G P L L C P A G H A V G I F R A A
AGCCCTAGGCCTATCTCTACCTCAAGGGAAGCTCCCGGGAGCCCTCCTGTGTCCCGCTGGCCATGCCGTCCGCAITTTTCAGAGCCGCT

Gene : HepCla
Segment# : 79
Offset : 1171
1st Codon : 1
L L C P A G H A V G I F R A A V C T R G V A K A V D F I P V
CTGCTCTGCCCTGCCGACACGCTGTGGGAATCTTTAGGGCTGCCGTCTGCACAAGGGAGTGCGCTAAGGCTGTGGATTTCATTCCCGTC

Gene : HepCla
Segment# : 80
Offset : 1186
1st Codon : 1
V C T R G V A K A V D F I P V E N L E T T M R S P V F T D N
GTGTGTACCAGAGCGCTGCCAAAGCCGTCGACTTTATCCCTGTGGAAAACCTCGAGACAACCATGAGGTCCCCCGTCTTCACAGACAAAT

Gene : HepCla
Segment# : 81
Offset : 1201
1st Codon : 1
E N L E T T M R S P V F T D N S S P P A V P Q S F Q V A H L
GAGAATCTGGAACCAATGAGAAGCCCTGTGTTACCGATAACTCCAGCCCTCCCGCTGTGCCTCAGTCTTCCAAGTGGCTCACCTC

Gene : HepCla
Segment# : 82
Offset : 1216
1st Codon : 1
S S P P A V P Q S F Q V A H L H A P T G S G K S T K V P A A
AGCTCCCCCTGCGCTCCCCCAAGCTTTCAGGTGCGCCATCTGCATGCCCTACCGGAAGCGGAAAGTCACCAAAGTGCCCTGCGCT

Gene : HepCla
Segment# : 83
Offset : 1231
1st Codon : 1
H A P T G S G K S T K V P A A Y A A Q G Y K V L V L N P S V
CACGCTCCCAAGGCTCCGGCAAAAGCACAAAGTCCCCGCTGCCTATGCGGCTCAGGGATACAAAGTGCTCGTGCTCAACCTAGCGTC

Gene : HepCla
Segment# : 84
Offset : 1246
1st Codon : 1
Y A A Q G Y K V L V L N P S V A A T L G F G A Y M S K A H G
TACGCTGCCCAAGGCTAATAGGTCCTGTGCTGAATCCCTCCGTGGCTGCCACACTGGGATTCCGAGCCTATATGTCCAAGGCTCACGGA

Gene : HepCla
Segment# : 85
Offset : 1261

Figure 26 (Cont)

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1st Codon : 1
A A T L G F G A Y M S K A H G I D P N I R T G V R T I T T G
GCCGCTACCCCTCGGCTTTGGCGCTTACATGAGCAAAGCCCATGGCATTGACCCCTAACATTAGGACAGGCGTCAGGACAATCACAACCGGA

Gene : HepCla
Segment# : 86
Offset : 1276
1st Codon : 1
I D P N I R T G V R T I T T G S P I T Y S T Y G K F L A D G
ATCGATCCCAATATCAGAACGGAGTGAGAACCATTACCACAGGCTCCCCCATTACCTATAGCACAATACGGAAGTTTCTGGCTGACGGA

Gene : HepCla
Segment# : 87
Offset : 1291
1st Codon : 1
S P I T Y S T Y G K F L A D G G C S G G A Y D I I I C D E C
AGCCCTATCACA TACTCCACCTATGGCAAATTCCTCGCGATGGCGGATGCTCCGGGGAGCCTATGACATTATCATTTGCGATGAGTGT

Gene : HepCla
Segment# : 88
Offset : 1306
1st Codon : 1
G C S G G A Y D I I I C D E C H S T D A T S I L G I G T V L
GGCTGTAGCGGAGGCGCTTACGATATCATTATCTGTGACGAATGCCATAGCACAGACGCTACCTCCATCCTCGGCATTGGCACAGTCTCT

Gene : HepCla
Segment# : 89
Offset : 1321
1st Codon : 1
H S T D A T S I L G I G T V L D Q A E T A G A R L V V L A T
CACTCCACCGATGCCAAGCATTTCTGGGAATCGGAACCGTCTGGATCAGGCTGAGACAGCCGGAGCCAGACTGGTCTGTCTGCCACA

Gene : HepCla
Segment# : 90
Offset : 1336
1st Codon : 1
D Q A E T A G A R L V V L A T A T P P G S V T V P H P N I E
GACCAAGCCGAACCGCTGGCGCTAGGCTCGTGGTCTGGCTACCGCTACCCCTCCCGGAAGCGTCACCGTCCCCCATCCCAATATCGAA

Gene : HepCla
Segment# : 91
Offset : 1351
1st Codon : 1
A T P P G S V T V P H P N I E E V A L S T T G E I P F Y G K
GCCACACCCCTCGCTCGTGACAGTGCCCTACCCCTAACATTGAGGAAGTGGCTCTGTCCACCACAGGCGAAATCCCTTTCTATGGCAAA

Gene : HepCla
Segment# : 92
Offset : 1366
1st Codon : 1
E V A L S T T G E I P F Y G K A I P L E V I K G G R H L I F
GAGGTGCGCCCTACGCACAACCGGAGAGATTCCCTTTACGGAAGGCTATCCCTCTGGAAGTGATTAAAGGAGGCAGACACCTCATCTTT

Gene : HepCla
Segment# : 93
Offset : 1381
1st Codon : 1
A I P L E V I K G G R H L I F C H S K K K C D E L A A K L V
GCCATTCCCCCTCGAGGTCATCAAAGGCGGAAGGCATCTGATTTTCTGTCACTCCAAGAAAAGTGTGACGAACTGGCTGCCAAACTGGTC

Gene : HepCla
Segment# : 94
Offset : 1396
1st Codon : 1
C H S K K K C D E L A A K L V A L G I N A V A Y Y R G L D V
TGCCATAGCAAAAAGAAATGCGATGAGCTCGCGCTAAGCTCGTGGCTCTGGGAATCAATGCCGTGCGCTATTACAGAGGCTCGACGTC

Gene : HepCla
Segment# : 95
Offset : 1411
1st Codon : 1
A L G I N A V A Y Y R G L D V S V I P T S G D V V V V A T D
GCCCTCGGCATTAAAGCTGTGGCTTACTATAGGGGACTGGATGTGTCGGTATTCCCAAGCGGAGACGTCGTGGTCTGGCTACCGAT

Figure 26 (Cont)

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Gene       : HepCla
Segment#   : 96
Offset     : 1426
1st Codon  : 1
S V I P T S G D V V V V A T D A L M T G Y T G D F D S V I D
AGCGTCATCCCTACCTCCGGCGATGTGGTCGTGGTCGCCACAGACGCTCTGATGACCGGATACACAGGCATTTGATAGCGTCATCGAT

Gene       : HepCla
Segment#   : 97
Offset     : 1441
1st Codon  : 1
A L M T G Y T G D F D S V I D C N T C V T Q T V D F S L D P
GCCCTCATGACAGGCTATACCGGAGACTTTGACTCCGTGATTGACTGTAACACATGCGCTCACCCAAACCGTCGACTTTAGCCTCGACCTT

Gene       : HepCla
Segment#   : 98
Offset     : 1456
1st Codon  : 1
C N T C V T Q T V D F S L D P T F T I E T T T L P Q D A V S
TGCAATACCTGTGTGACACAGACAGTGGATTTCTCCCTGGATCCACATTACAATCGAAACCACAACCTCCCCCAAGACGCTGTGTCC

Gene       : HepCla
Segment#   : 99
Offset     : 1471
1st Codon  : 1
T F T I E T T T L P Q D A V S R T Q R R G R T G R G K P G I
ACCTTTACCATTTGAGACAACCACTGCCTCAGGATGCCGTGAGCAGAAACCCAAAGGAGAGGCAGAAACCGGAAGGGGAAAGCCTGGCATT

Gene       : HepCla
Segment#   : 100
Offset     : 1486
1st Codon  : 1
R T Q R R G R T G R G K P G I Y R F V A P G E R P S G M F D
AGGACACAGAGAAGGGGAAGGACAGGCGAGAGCAAACCCGGAATCTATAGGTTTGTGGCTCCCGGAGAGAGACCTTCGGCATGTTTCGAT

Gene       : HepCla
Segment#   : 101
Offset     : 1501
1st Codon  : 1
Y R F V A P G E R P S G M F D S S V L C E C Y D A G C A W Y
TACAGATTCTGTCGCCCCTGCGGAAGGCCTAGCGGAATGTTTACTCCAGCGTCTGTGTGAGTGTTACGATGCCGGATGCGCTTGGTATT

Gene       : HepCla
Segment#   : 102
Offset     : 1516
1st Codon  : 1
S S V L C E C Y D A G C A W Y E L T P A E T T V R L R A Y M
AGCTCCGTGCTCTCGGAATGCTATGACGCTGGCTGTGCTGGTAAGAACTGACACCCGCTGAGACAAACCGTCAGGCTCAGGCTTACATG

Gene       : HepCla
Segment#   : 103
Offset     : 1531
1st Codon  : 1
E L T P A E T T V R L R A Y M N T P G L P V C Q D H L E F W
GAGCTCACCCCTGCGGAACCAAGTGAAGTATATGAATACCCCTGGCCTCCCCGTCGCAAGACCATCTGGAATTCTGGT

Gene       : HepCla
Segment#   : 104
Offset     : 1546
1st Codon  : 1
N T P G L P V C Q D H L E F W E G V F T G L T H I D A H F L
AACAACCCGGACTGCCTGTGTGTGACGATCACTCGAGTTTGGGAAGGCGTCTTCACAGGCTCACCCATATCGATGCCAATTCCTCT

Gene       : HepCla
Segment#   : 105
Offset     : 1561
1st Codon  : 1
E G V F T G L T H I D A H F L S Q T K Q S G E N F P Y L V A
GAGGGAGTGTTTACCGACTGACACACATTGACGCTCACTTTCTGTCCAGACAAAGCAAAGCGGAGAGAATTTCCCTTACCTCGTGGCT

Gene       : HepCla
Segment#   : 106

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Figure 26 (Cont)

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Offset : 1576
1st Codon : 1
S Q T K Q S G E N F P Y L V A Y Q A T V C A R A Q A P P P S
AGCCAAACCAACAGTCCGGGAAAACTTCCCTATCTGGTCGCCTATCAGGCTACCGTCTGGCTAGGGCTCAGGCTCCCCCTCCCTCC

Gene : HepCla
Segment# : 107
Offset : 1591
1st Codon : 1
Y Q A T V C A R A Q A P P P S W D Q M W K C L I R L K P T L
TACCAAGCCACAGTGTGTGCCAGAGCCCAAGCCCCCTCCCTAGCTGGGACCAATGTGGAAGTGTCTGATTAGGCTCAAGCCTACCCCTC

Gene : HepCla
Segment# : 108
Offset : 1606
1st Codon : 1
W D Q M W K C L I R L K P T L H G P T P L L Y R L G A V Q N
TGGGATCAGATGTGGAATGCCTCATCAGACTGAAACCCACACTGCATGGCCCTACCCCTCTGCTCTACAGACTGGGAGCCGTCAGAAAT

Gene : HepCla
Segment# : 109
Offset : 1621
1st Codon : 1
H G P T P L L Y R L G A V Q N E V T L T H P V T K Y I M T C
CAGGACCCACACCCCTCCTGTATAGGCTCGGCGCTGTGCAAAACGAAGTGACACTGACACACCCCTGTGACAAAGTATATCATGACCTGT

Gene : HepCla
Segment# : 110
Offset : 1636
1st Codon : 1
E V T L T H P V T K Y I M T C M S A D L E V V T S T W V L V
GAGGTCACCCCTACCCATCCCGTCACCAATACATTATGACATGCATGAGCGCTGACCTCGAGGTCGTGACAAGCACATGGGTCTGGTCT

Gene : HepCla
Segment# : 111
Offset : 1651
1st Codon : 1
M S A D L E V V T S T W V L V G G V L A A L A A Y C L S T G
ATGTCCGCGATCTGGAGTGGTCACTCCACCTGGGTGCTCGTGGGAGCGCTCTGGCTGCCCTCGCGCTTACTGTCTGTCCACCGGA

Gene : HepCla
Segment# : 112
Offset : 1666
1st Codon : 1
G G V L A A L A A Y C L S T G C V V I V G R I V L S G K P A
GGCGAGTGCTCGCGCTCTGGCTGCCTATTGCCTCAGCACAGGCTGTGTGGTCATCGTCGGCAGAATCGTCTGTCCGGCAAAACCGCT

Gene : HepCla
Segment# : 113
Offset : 1681
1st Codon : 1
C V V I V G R I V L S G K P A I I P D R E V L Y R E F D E M
TGCGTCTGTATGTGGGAAGGATTGTCTCAGCGGAAAGCCTGCCATTATCCCTGACAGAGAGTCTGTATAGGGAATCGATGAGATG

Gene : HepCla
Segment# : 114
Offset : 1696
1st Codon : 1
I I P D R E V L Y R E F D E M E E C S Q H L P Y I E Q G M M
ATCATTCGCGATAGGGAAGTGTCTACAGAGAGTTTGACGAAATGGAAGAGTGTAGCCAACACCTCCCTATATCGAACAGGGAATGATG

Gene : HepCla
Segment# : 115
Offset : 1711
1st Codon : 1
E E C S Q H L P Y I E Q G M M L A E Q F K Q K A L G L L Q T
GAGGAATGCTCCCGCATCTGCCTTACATTGAGCAAGGCATGATGCTCGCGAACAGTTTAAGCAAAAGGCTCTGGGACTGCTCCAGACA

Gene : HepCla
Segment# : 116
Offset : 1726
1st Codon : 1
L A E Q F K Q K A L G L L Q T A S R Q A E V I A P A V Q T N

Figure 26 (Cont)

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CTGGCTGAGCAATTCAAACAGAAAGCCCTCGGCCTCTGCAAAACCGCTAGCAGACAGGCTGAGGTCAATCGCTCCCGCTGTGCAAAACCAAT

Gene : HepCla

Segment# : 117

Offset : 1741

1st Codon : 1

A S R Q A E V I A P A V Q T N W Q K L E V F W A K H M W N F
GCCTCCAGGCAAGCCGAAGTGATTGCCCTGCCGTCCAGACAACTGGCAGAACTGGAAGTGTTTTGGGCTAAGCATATGTGGAACCTT

Gene : HepCla

Segment# : 118

Offset : 1756

1st Codon : 1

W Q K L E V F W A K H M W N F I S G I Q Y L A G L S T L P G
TGGCAAAAGCTCGAGGTCTTCTGGGCCAAACACATGTGGAATTTCAITAGCGGAATCCAATACCTCGCCGGACTGTCCACCTCCCCGGA

Gene : HepCla

Segment# : 119

Offset : 1771

1st Codon : 1

I S G I Q Y L A G L S T L P G N P A I A S L M A P T A A V T
ATCTCCGGCATTAGTATCTGGCTGGCCTCAGCACTGCTGGCAATCCGCTATCGCTAGCCTCATGGCTTTCACAGCGCTGTGACA

Gene : HepCla

Segment# : 120

Offset : 1786

1st Codon : 1

N P A I A S L M A P T A A V T S P L T T S Q T L L F N I L G
AACCCTGGCATTGCTTCCCTGATGGCCTTACCGCTGCCGTCACTCCCCCTCACCACAAGCCAAACCTCCTGTTTAACTTCTGGGA

Gene : HepCla

Segment# : 121

Offset : 1801

1st Codon : 1

S P L T T S Q T L L F N I L G G W V A A Q L A A P G A A T A
AGCCCTCTGACAACCTCCAGACACTGCTCTTCAATATCCTCGGCGGATGGGTGCGCGCTCAGCTGCGCGCTCCCGGAGCCGCTACCGCT

Gene : HepCla

Segment# : 122

Offset : 1816

1st Codon : 1

G W V A A Q L A A P G A A T A F V G A G L A G A A I G S V G
GGCTGGGTGGCTGCCAACTGGCTGCCCTGGCGCTGCCACAGCCTTTGTGGGAGCCGGAAGTGGCTGGCGCTGCCATTTGGCTCCGTGGGA

Gene : HepCla

Segment# : 123

Offset : 1831

1st Codon : 1

F V G A G L A G A A I G S V G L G K V L V D I L A G Y G A G
TTCTGTCGGCGCTGGCCTGCCCGGAGCCGCTATCGGAAGGTGGGCTCGGCAAGTGTCTGTGGATATCCTGCCCGGATACGGAGCCGGA

Gene : HepCla

Segment# : 124

Offset : 1846

1st Codon : 1

L G K V L V D I L A G Y G A G V A G A L V A P K I M S G E V
CTGGGAAAGTCTGGTTCGACATTCTGGCTGGCTATGGCGCTGGCGTGGCCGAGCCCTCGTGGCTTTCAAATCATGAGCGGAGAGGTC

Gene : HepCla

Segment# : 125

Offset : 1861

1st Codon : 1

V A G A L V A P K I M S G E V P S T E D L V N L L P A I L S
GTGGCTGGCGCTCTGGTGGCTTTAAGATTATGTCCGGCGAAGTGCTAGCAGAGGATCTGGTCAACCTCCTGCCCTGCCATTCTGTCC

Gene : HepCla

Segment# : 126

Offset : 1876

1st Codon : 1

P S T E D L V N L L P A I L S P G A L V V G V V C A A I L R
CCCTCCACCGAAGACCTCGTGAATCTGCTCCCGCTATCCTCAGCCCTGGCGCTCTGGTCTGTGGGAGTGGTCTGCCCTGCCATTCTGAGA

Gene : HepCla

Figure 26 (Cont)

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Segment# : 127
Offset : 1891
1st Codon : 1
P G A L V V G V V C A A I L R R H V G P G E G A V Q W M N R
CCCGGAGCCCTCGTGGTCGGCGTCGTGTGTCGCTATCCTCAGGAGACACGTCGGCCCTGGCGAAGGCGCTGTGCAATGGATGAACAGA

Gene : HepCla
Segment# : 128
Offset : 1906
1st Codon : 1
R H V G P G E G A V Q W M N R L I A F A S R G N H V S P T H
AGGCATGTGGGACCGGAGAGGGAGCCGTCCAGTGGATGAATAGGCTCATCGCTTTCGCTAGCAGAGGCAATCAGTCAGCCCTACCCAT

Gene : HepCla
Segment# : 129
Offset : 1921
1st Codon : 1
L I A F A S R G N H V S P T H Y V P E S D A A A R V T A I L
CTGATTGCTTTGCTCCAGGGAAACATGTGTCCCCACACACTATGTGCTGAGTCCGACGCTGCCGCTAGGGTCACCGCTATCCTC

Gene : HepCla
Segment# : 130
Offset : 1936
1st Codon : 1
Y V P E S D A A A R V T A I L S S L T V T Q L L R R L H Q W
TAGCTCCCGAAAGCGATGCCGCTGCCAGAGTGACAGCCATTCTGTCCAGCCTCACCGTCACCCAACTGCTCAGGAGACTGCATCAGTGG

Gene : HepCla
Segment# : 131
Offset : 1951
1st Codon : 1
S S L T V T Q L L R R L H Q W I S S E C T T P C S G S W L R
AGCTCCCTGACAGTGACACAGCTCCTGAGAAGGCTCCACCAATGGATTAGCTCCGAGTGATACCACACCTGTAGCGGAAGCTGGCTGAGA

Gene : HepCla
Segment# : 132
Offset : 1966
1st Codon : 1
I S S E C T T P C S G S W L R D I W D W I C E V L S D F K T
ATCTCCAGCGAATGCACAACCCCTTGCTCCGGCTCCTGGCTCAGGGATATCTGGGACTGGATCTGTGAGGTCTGTCCGACTTTAAGACA

Gene : HepCla
Segment# : 133
Offset : 1981
1st Codon : 1
D I W D W I C E V L S D F K T W L K A K L M P Q L P G I P F
GACATTGCGGATTGGATTGCGAAGTGCTCAGCGATTTCAAAACCTGGCTGAAAGCCAAACTGATGCCCCAACTGCCCTGGCATTCCCTTT

Gene : HepCla
Segment# : 134
Offset : 1996
1st Codon : 1
W L K A K L M P Q L P G I P F V S C Q R G Y K G V W R G D G
TGGCTCAAGGCTAAGCTCATGCTCAGCTCCCCGGAATCCCTTTCTGTGAGTGTGAGAGGCTATAAGGGAGTGTGAGGGGAGACGGA

Gene : HepCla
Segment# : 135
Offset : 2011
1st Codon : 1
V S C Q R G Y K G V W R G D G I M H T R C H C G A E I T G H
GTGTCTGCCAAAGGGGATACAAAGGCGTCTGGAGAGGGGATGGCATTATGCATACCAGATGCCATTGCCGAGCCGAAATCACAGGCCAT

Gene : HepCla
Segment# : 136
Offset : 2026
1st Codon : 1
I M H T R C H C G A E I T G H V K N G T M R I V G P R T C R
ATCATGCACACAAGGTGTCACTGTGGCGCTGAGATTACCGACACGTCAGAATGGCACAATGAGAATCGTGGGCCCTAGGACATGACAGA

Gene : HepCla
Segment# : 137
Offset : 2041
1st Codon : 1

Figure 26 (Cont)

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V K N G T M R I V G P R T C R N M W S G T P P I N A Y T T G
GTGAAAAACCGAACCATGAGGATTGTGGGACCCAGAACCTGTAGGAATATGTGGAGCGGAACCTTCCCATTAACGCTTACACAAACCGGA

Gene : HepCla
Segment# : 138
Offset : 2056
1st Codon : 1

N M W S G T P P I N A Y T T G P C T P L P A P N Y T F A L W
AACATGTGGTCCGGCACATTCCCTATCAATGCCCTATACCACAGGCCCTTGCACACCCCTCCCGCTCCCAATTACACATTGCTCTGTGG

Gene : HepCla
Segment# : 139
Offset : 2071
1st Codon : 1

P C T P L P A P N Y T F A L W R V S A E E Y V E I R R V G D
CCCTGTACCCCTCTGCTGCCCTAACTATACCTTTGCCCTTGCAGATGTGTCGCGCGAAGAGTATGTGGAAATCAGAAGGGTGGCGAT

Gene : HepCla
Segment# : 140
Offset : 2086
1st Codon : 1

R V S A E E Y V E I R R V G D F H Y V T G M T T D N L K C P
AGGGTCAGCGCTGAGGAATACGTCGAGATTAGGAGAGTGGGAGACTTTCATATGTGACAGGCATGACCACAGACAATCTGAAATGCCCT

Gene : HepCla
Segment# : 141
Offset : 2101
1st Codon : 1

P H Y V T G M T T D N L K C P C Q V P S P E F P T E L D G V
TTCCATTAGCTACCGGAATGACAACGATAACCTCAAGTGTCCCTGTGAGTCCCTCCCGGAATTCCTTACCGAACTGGATGGCGTC

Gene : HepCla
Segment# : 142
Offset : 2116
1st Codon : 1

C Q V P S P E F P T E L D G V R L H R F A P P C K P L L R E
TGCCAAAGTGCCTAGCCCTGAGTTTTTACAGAGCTGACCGAGTGAGACTGCATAGGTTTGCCCTCCCTGTAGCCTCTGCTCAGGGAA

Gene : HepCla
Segment# : 143
Offset : 2131
1st Codon : 1

R L H R F A P P C K P L L R E E V S F R V G L H E Y P V G S
AGGCTCCACAGATTGCTCCCGCTGCAAAACCCCTCTGAGAGAGGAAGTGTCTTCAGAGTGGGACTGCATGAGTATCCCGTGGCTCC

Gene : HepCla
Segment# : 144
Offset : 2146
1st Codon : 1

E V S F R V G L H E Y P V G S Q L P C E P E P D V A V L T S
GAGGTCAGCTTTAGGGTGGCCCTCCACGAATACCTGTGGGAAGCCAACTGCCCTTGGGAACCCGAACCGATGTGGCTGTGCTCAGCTCC

Gene : HepCla
Segment# : 145
Offset : 2161
1st Codon : 1

Q L P C E P E P D V A V L T S M L T D P S H I T A E A A G R
CAGCTCCCTGTGAGCCTGAGCCTGACGTGGCGTCTGACAAGCATGCTGACAGACCTAGCCATATCACAGCGAAGCCGCTGGCAGA

Gene : HepCla
Segment# : 146
Offset : 2176
1st Codon : 1

M L T D P S H I T A E A A G R R L A R G S P P S M A S S S A
ATGCTCACCGATCCCTCCACATTACGCTGAGGCTGCCGGAAGGAGACTGGCTAGGGGAAGCCCTCCCTCCATGGCTAGCTCCAGCGCT

Gene : HepCla
Segment# : 147
Offset : 2191
1st Codon : 1

R L A R G S P P S M A S S S A S Q L S A P S L K A T C T A N
AGGCTCGCCAGAGGCTCCCCCTAGCATGGCTCCAGCTCCGCTCCAGCTCAGCGCTCCCTCCCTGAAAGCCACATGCACAGCCAAT

Figure 26 (Cont)

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Gene : HepCla
Segment# : 148
Offset : 2206
1st Codon : 1
S Q L S A P S L K A T C T A N H D S P D A E L I E A N L L W
AGCCAACTGTCGCCCCCTAGCCTCAAGGCTACCTGTACCGCTAACCATGACTCCCCCGATGCGAACTGATTGAGGCTAACCTCCTGTGG

Gene : HepCla
Segment# : 149
Offset : 2221
1st Codon : 1
H D S P D A E L I E A N L L W R Q E M G G N I T R V E S E N
CAOGATAGCCCTGACGCTGAGCTCATCGAAGCCAATCTGCTCTGGAGACAGGAAATGGGAGGCAATATCACAAGGGTCGAGTCCGAGAAT

Gene : HepCla
Segment# : 150
Offset : 2236
1st Codon : 1
R Q E M G G N I T R V E S E N K V V I L D S F D P L V A E E
AGGCAAGAGATGGGCGGAAACATTACCAGAGTGGAAAGCGAAACAAAGTGGTCATCCTCGACTCCTTCGATCCCGCTCGTGGCTGAGGAA

Gene : HepCla
Segment# : 151
Offset : 2251
1st Codon : 1
K V V I L D S F D P L V A E E D E R E I S V P A E I L R K S
AAGTCTGTGATTCTGGATAGCTTTGACCCCTCTGGTCCCGAAGAGGATGAGAGAGAGATTAGCGTCCCGCTGAGATTCTGAGAAAGTCC

Gene : HepCla
Segment# : 152
Offset : 2266
1st Codon : 1
D E R E I S V P A E I L R K S R R F A Q A L P V W A R P D Y
GACGAAGGGAAATCTCGTGCTGCCGAAATCCTCAGGAAAGCAGAAGGTTTGCCCAAGCCCTCCCGCTCTGGGCTAGGCGCTGACTAT

Gene : HepCla
Segment# : 153
Offset : 2281
1st Codon : 1
R R F A Q A L P V W A R P D Y N P P L V E T W K K P D Y E P
AGGAGATTGCTCAGGCTCTGCTGTGGGCGAGACCGATTACAATCCCCCTCTGGTCGAGACATGGAAAAAGCCCTGACTATGAGCCT

Gene : HepCla
Segment# : 154
Offset : 2296
1st Codon : 1
N P P L V E T W K K P D Y E P P V V H G C P L P P P R S P P
AACCCTCCCCCTGTTGGAACCTGGAAGAAACCGATTACGAACCCCTGTGGTCCACGGATGCCCTCTGCCCTCCCCCTAGGTCCCCCCT

Gene : HepCla
Segment# : 155
Offset : 2311
1st Codon : 1
P V V H G C P L P P P R S P P V P P P R K K R T V V L T E S
CCCGTGTGATGGCTGTCCCTCCCTCCCTCCAGAACCCCTCCCGTCCCCCTCCAGAAAGAAAGGACAGTGGTCTGACAGAGTCC

Gene : HepCla
Segment# : 156
Offset : 2326
1st Codon : 1
V P P P R K K R T V V L T E S T L S T A L A E L A T K S P G
GTGCTCCCCCTAGGAAAAAGAGAACGCTGCTCTACCGAAAGCACTGTCCACCGCTCTGGCTGAGCTCGCCACAAAGTCTCTCGGA

Gene : HepCla
Segment# : 157
Offset : 2341
1st Codon : 1
T L S T A L A E L A T K S P G S S S T S G I T G D N T T T S
ACCTCAGCACAGCCCTCGCGAACTGGCTACCAAAAGCTTTGGCTCCAGTCCACCTCCGGCAATTACCGGAGACAAATACCACAACTCC

Gene : HepCla
Segment# : 158
Offset : 2356

Figure 26 (Cont)

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1st Codon : 1
S S S T S G I T G D N T T T S S E P A P S G C P P D S D A E
AGCTCCAGCACAAAGCGGAATCACAGGCGATAACACAACCAAGCTCCGAGCCTGCCCCCTAGCGGATGCCCTCCCGATAGCGATGCCGAA

Gene : HepCla
Segment# : 159
Offset : 2371
1st Codon : 1
S E P A P S G C P P D S D A E S Y S S M P P L E G E P G D P
AGCGAACCOCCTCCCTCCGGCTGTCCCCCTGACTCCGAGCTGAGTCTACTCCAGCATGCCCCCTCTGGAAGGCGAAACCCGGAGACCCCT

Gene : HepCla
Segment# : 160
Offset : 2386
1st Codon : 1
S Y S S M P P L E G E P G D P D L S D G S W S T V S S E A G
AGCTATAGTCCATGCCCTCCCTCGAGGGAGAGCCTGGCGATCCCGATCTGTCCGACGGAAGCTGGAGCACAGTGTCCAGCGAAGCCGGA

Gene : HepCla
Segment# : 161
Offset : 2401
1st Codon : 1
D L S D G S W S T V S S E A G T E D V V C C S M S Y S W T G
GACCTCAGCGATGGCTCCTGGTCCACGTCAGCTCCGAGGCTGGCACAGAGATGTGGTCTGCTGTAGCATGAGCTATAGCTGGACCGGA

Gene : HepCla
Segment# : 162
Offset : 2416
1st Codon : 1
T E D V V C C S M S Y S W T G A L V T P C A A E E Q K L P I
ACCGAAGAGCTCGTGTGTGCTCCATGTCTACTCTCGGACAGGCGCTCTGGTCAACCCCTTGCGCTGCCGAAGAGCAAAGCTCCCCATT

Gene : HepCla
Segment# : 163
Offset : 2431
1st Codon : 1
A L V T P C A A E E Q K L P I N A L S N S L L R H H N L V Y
GCCCTCGTGACACCCCTGTGCGCTGAGGAACAGAAAGCTGCTATCAATGCCCTCAGCAATAGCCTCTGAGACACCATACCTCGTGTAT

Gene : HepCla
Segment# : 164
Offset : 2446
1st Codon : 1
N A L S N S L L R H H N L V Y S T T S R S A C Q R Q K K V T
AAGCTCTGTCCAACTCCCTGCTCAGGCATCACAATCTGGTCTACTCCACCACAAGCAGAAGCGCTTGCCAAAGGCAAAGAAAGTGACA

Gene : HepCla
Segment# : 165
Offset : 2461
1st Codon : 1
S T T S R S A C Q R Q K K V T F D R L Q V L D S H Y Q D V L
AGCACAACCTCCAGGTCGCGCTGTCAGAGACAGAAAAGGTCACTTTGACAGACTGCAAGTGCTGACTCCCACTATCAGGATGTGCTC

Gene : HepCla
Segment# : 166
Offset : 2476
1st Codon : 1
F D R L Q V L D S H Y Q D V L K E V K A A A S K V K A N L L
TTCGATAGGCTCCAGGTCCTGGATAGCCATTACCAAGAGCTCCTGAAAGAGGTCAAGGCTGCCGCTAGCAAAGTGAAAGCCAATCTGCTC

Gene : HepCla
Segment# : 167
Offset : 2491
1st Codon : 1
K E V K A A A S K V K A N L L S V E E A C S L T P P H S A K
AAGCAAGTGAAAGCGCTGCCTCCAGGTCAAGGCTAACCTCCTGTCCGTGGAAGAGGCTTGCTCCCTGACACCCCTCACTCCGCCAAA

Gene : HepCla
Segment# : 168
Offset : 2506
1st Codon : 1
S V E E A C S L T P P H S A K S K F G Y G A K D V R C H A R
AGCGTCGAGGAAGCTGTAGCCTCACCTTCCCCATAGCGCTAAGTCCAGTTTGGCTATGGCGCTAAGGATGTGAGATGCCATGCCAGA

Figure 26 (Cont)

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Gene : HepCla
Segment# : 169
Offset : 2521
1st Codon : 1
S K F G Y G A K D V R C H A R K A V A H I N S V W K D L L E
AGCAAATTCGGATACGGAGCCAAAGACGTCAGGTGTCAGCTAGGAAAGCCGTGCGCCATATCAATAGCGTCTGGAAAGACCTCCTGGAA

Gene : HepCla
Segment# : 170
Offset : 2536
1st Codon : 1
K A V A H I N S V W K D L L E D S V T P I D T T I M A K N E
AAGGCTGTGGCTCACATTAACCTCGTGTGGAAGGATCTGCTGAGGATAGCGTCACCCCTATCGATACCACAATCATGGCCAAAACGAA

Gene : HepCla
Segment# : 171
Offset : 2551
1st Codon : 1
D S V T P I D T T I M A K N E V F C V Q P E K G G R K P A R
GACTCGGTGACACCCATTGACACAACCATTAAGGCTAAGAAATAGGTCTTCTGTGTGCAACCCGAAAAGGGAGGCAGAAAGCCTGCCAGA

Gene : HepCla
Segment# : 172
Offset : 2566
1st Codon : 1
V F C V Q P E K G G R K P A R L I V F P D L G V R V C E K M
GTGTTTTCGGTCCAGCCTGAGAAAGGCGGAAGGAAACCGCTAGGCTCATCGTCTTCCCTGACCTCGGCGTCAGGGTCTGCGAAAAGATG

Gene : HepCla
Segment# : 173
Offset : 2581
1st Codon : 1
L I V F P D L G V R V C E K M A L Y D V V S K L P L A V M G
CTGATGTGTTCCTCCGATCTGGGAGTGAGACTGTGTGAGAAAATGGCTCTGTATGACGTGCTGCAAGCTCCCCCTCGGCGTCATGGGA

Gene : HepCla
Segment# : 174
Offset : 2596
1st Codon : 1
A L Y D V V S K L P L A V M G S S Y G F Q Y S P G Q R V E F
GCCCTCTACGATGTGGTCAGCAAACTGCCTCTGGCTGTGATGGCTCCAGCTATGGCTTTCAGTATAGCCCTGGCCAAAGGGTCGAGTTT

Gene : HepCla
Segment# : 175
Offset : 2611
1st Codon : 1
S S Y G F Q Y S P G Q R V E F L V Q A W K S K K T P M G F S
AGCTCCTACGATTCCAATACTCCCGGACAGAGAGTGGAAATCCTCGTGCAGCCTGGAAGTCCAAGAAAACCCCTATGGGATTCTCC

Gene : HepCla
Segment# : 176
Offset : 2626
1st Codon : 1
L V Q A W K S K K T P M G F S Y D T R C F D S T V T E S D I
CTGGTCCAGGCTTGGAAGCAAAAAGACACCCATGGGCTTTAGCTATGACACAAGGTGTTTCGATAGCACAGTGACAGAGTCCGACATT

Gene : HepCla
Segment# : 177
Offset : 2641
1st Codon : 1
Y D T R C F D S T V T E S D I R T E E A I Y Q C C D L D P Q
TACGATACCAGATGCTTTGACTCCACCGTCACCGAAAGCGATATCAGAACCGAAGAGGCTATCTATCAGTGTGCGATCTGGATCCCCAA

Gene : HepCla
Segment# : 178
Offset : 2656
1st Codon : 1
R T E E A I Y Q C C D L D P Q A R V A I K S L T E R L Y V G
AGGACAGAGGAAGCCATTACCAATGCTGTGACCTCGACCCCTCAGGCTAGGGTCGCCATTAAGTCCCTGACAGAGAGACTGTATGTGGGA

Gene : HepCla
Segment# : 179

Figure 26 (Cont)

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Offset : 2671
1st Codon : 1
A R V A I K S L T E R L Y V G G P L T N S R G E N C G Y R R
GCCAGAGTGGCTATCAAAGCCTCACCGAAAGGCTCTACGTGGCGGACCCCTCACCAATAGCAGAGGCGAAAACGTGGCTATAGGAGA

Gene : HepCla
Segment# : 180
Offset : 2686
1st Codon : 1
G P L T N S R G E N C G Y R R C R A S G V L T T S C G N T L
GGCCCTCTGACAAACTCCAGGGGAGAGAATTGCGGATACAGAAGGTGTAGGGCTAGCGGAGTGCTACCACAAGCTGTGGCAATACCCCTC

Gene : HepCla
Segment# : 181
Offset : 2701
1st Codon : 1
C R A S G V L T T S C G N T L T C Y I K A R A A C R A A G L
TGCAGAGCCTCGGGCGTCTGACAACTCCTGCGGAAACACACTGACATGCTATATCAAAGCCAGAGCCGCTTGCGAGCCGCTGGCCCTC

Gene : HepCla
Segment# : 182
Offset : 2716
1st Codon : 1
T C Y I K A R A A C R A A G L Q D C T M L V C G D D L V V I
ACCTGTATACATTAAAGCTAGGGCTGCCTGTAGGGCTGCCGACTGCAAGACTGTACCATGCTGGTCTGCGGAGACGATCTGGTGTGATT

Gene : HepCla
Segment# : 183
Offset : 2731
1st Codon : 1
Q D C T M L V C G D D L V V I C E S A G V Q E D A A S L R A
CAGGATTGCACAACTGCTGTGTGGCGATGACCTGTGGTCTATCTGTGAGTCCGCCGAGTGCAAGAGGATGCCGCTAGCCCTCAGGGCT

Gene : HepCla
Segment# : 184
Offset : 2746
1st Codon : 1
C E S A G V Q E D A A S L R A F T E A M T R Y S A P P G D P
TGCGAAAGCGCTGGCGCTCAGGAAGACGCTGCCTCCTGAGAGCCTTTACCGAAGCCATGACCAGATACTCCGCCCTCCCGGAGACCCCT

Gene : HepCla
Segment# : 185
Offset : 2761
1st Codon : 1
F T E A M T R Y S A P P G D P P Q P E Y D L E L I T S C S S
TTACAGAGGCTATGACAAGGTATAGCGCTCCCCCTGGCGATCCCCCTCAGCCTGAGTATGACCTCGAGCTCATCACAAGCTGTAGCTCC

Gene : HepCla
Segment# : 186
Offset : 2776
1st Codon : 1
P Q P E Y D L E L I T S C S S N V S V A H D G A G K R V Y Y
CCCCAACCGAATACGATCTGGAAGTATTACCTCCTGCTCCAGCAATGTGTCCGTGGCTCAGCATGGCGCTGGCAAAGGGTCTACTAT

Gene : HepCla
Segment# : 187
Offset : 2791
1st Codon : 1
N V S V A H D G A G K R V Y Y L T R D P T T P L A R A A W E
AACGTCAGCGTCCCATGACGGAGCCGGAAGAGAGTGTATTACCTCACCAGAGACCCCTACCACAGCCCTCGCCAGAGCCGCTTGGGAA

Gene : HepCla
Segment# : 188
Offset : 2806
1st Codon : 1
L T R D P T T P L A R A A W E T A R H T P V N S W L G N I I
CTGACAAGGGATCCCAACACCCCTCTGGCTAGGGCTGCCTGGGAGACAGCCAGACACACCCGCTCAACTCCTGGCTCGGCAATATCATT

Gene : HepCla
Segment# : 189
Offset : 2821
1st Codon : 1
T A R H T P V N S W L G N I I M F A P T L W A R M I L M T H

Figure 26 (Cont)

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ACCGCTAGGCATACCCCTGTGAATAGCTGGCTGGGAAACATTATCATGTTCCGCTCCACACTGTGGGCCAGAATGATTCTGATGACCCAT

Gene : HepCla

Segment# : 190

Offset : 2836

1st Codon : 1

M F A P T L W A R M I L M T H F F S V L I A R D Q L E Q A L
ATGTTTGGCCCTACCCCTCTGGGCTAGGATGATCCTCATGACACACTTTTCTCCGTGCTCATGGCTAGGGATCAGCTCGAGCAAGCCCTC

Gene : HepCla

Segment# : 191

Offset : 2851

1st Codon : 1

F F S V L I A R D Q L E Q A L D C E I Y G A C Y S I E P L D
TTCCTTAGCGTCTGATTGCCAGAGACCACTGGAACAGGCTCTGGATTGCGAAATCTATGGCGCTTGCTATAGCATTGAGCCTCTGGAT

Gene : HepCla

Segment# : 192

Offset : 2866

1st Codon : 1

D C E I Y G A C Y S I E P L D L P P I I Q R L H G L S A F S
GACTGTGAGATTACGGAGCCTGTTACTCCATCGAAGCCCTCGACCTCCCCCTATCATTCAGAGACTGCATGGCCTCAGCGCTTCTCTC

Gene : HepCla

Segment# : 193

Offset : 2881

1st Codon : 1

L P P I I Q R L H G L S A F S L H S Y S P G E I N R V A A C
CTGCCTCCCATTTATCCAAAGGCTCCACGGACTGTCCGCCTTAGCCTCCACTCTACTCCCCGGAGAGATTAAACAGAGTGGCTGCCTGT

Gene : HepCla

Segment# : 194

Offset : 2896

1st Codon : 1

L H S Y S P G E I N R V A A C L R K L G V P P L R A W R H R
CTGCATAGCTATAGCCCTGGCGAAATCAATAGGTCGCCGCTTGCCCTCAGGAACTGGGAGTGCTCCCTCAGGGCTTGGAGACACAGA

Gene : HepCla

Segment# : 195

Offset : 2911

1st Codon : 1

L R K L G V P P L R A W R H R A R S V R A R L L A R G G R A
CTGAGAAAGCTCGGGTCCCCCTCTGAGAGCCTGGAGCATAGGGCTAGGTCCTGAGAGCCAGACTGCTGCCAGAGGCGGAAGGGCT

Gene : HepCla

Segment# : 196

Offset : 2926

1st Codon : 1

A R S V R A R L L A R G G R A A I C G K Y L P N W A V R T K
GCCAGAAGCGTCAGGCTAGGCTCCTGGCTAGGGGAGGCAGAGCCGCTATCTGTGGCAAATACCTCTTCAATTGGGCTGTGAGAACCAAA

Gene : HepCla

Segment# : 197

Offset : 2941

1st Codon : 1

A I C G K Y L P N W A V R T K L K L T P I A A A G R L D L S
GCCATTTCCGGAAGTATCTGTTAACTGGGCGTCAGGACAAAGCTCAAGCTCACCCCTATCGCTGCCGCTGGCAGACTGGATCTGTCC

Gene : HepCla

Segment# : 198

Offset : 2956

1st Codon : 1

L K L T P I A A A G R L D L S G W P T A G Y S G G D I Y H S
CTGAAACTGACACCATTCGCCGCTGCCGGAAGGCTCGACCTCAGCGGATGGTTTACCGCTGGCTATAGCGGAGGCGATATCTATCACTCC

Gene : HepCla

Segment# : 199

Offset : 2971

1st Codon : 1

G W P T A G Y S G G D I Y H S V S H A R P R W F W F C L L L
GGCTGGTTACAGCCGGATCTCGGGCGGAGACATTTACCATAGCGTCAGCCATGCCAGACCCAGATGGTTTGGTTTTCGCTCTGTCTC

Gene : HepCla

Figure 26 (Cont)

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Segment# : 200
Offset : 2986
1st Codon : 1
V S H A R P R W F W F C L L L L A A G V G I Y L L P N R A A
GTGTCCACGCTAGGCCTAGGTGGTTCCTGGTCTGTCTGCTCCTGCTCGCCGCTGGCGTCGGCATTACCTCCTGCCTAACAGAGCCGCT

Gene : HepC1a
Segment# : 201
Offset : 3001
1st Codon : 1
L A A G V G I Y L L P N R A A
CTGGCTGCGGAGTGGGAATCTATCTGCTCCCCAATAGGGCTGCC

Segments in scrambled order:

HepC1a #77
V I P V R R R R G D S R G S L L S P R P I S T L K G S S G G P
GTGATTCCTCGTCAGGAGAAGGGGAGACTCCAGGGGAAGCCTCCTGTCCCCCAGACCCATTAGCTATCTGAAAGGCTCCAGCGGAGGCCCT

HepC1a #68
A R R G R E I L L G P A D G M V S K G W R L L A P I T A Y A
GCCAGAAGGGGAAGGAAATCTCTGGGACCCGCTGACGGAATGGTCAGCAAAGGCTGGAGGCTCCTGGCTCCCATACCGCTTACGCT

HepC1a #143
R L H R F A P P C K P L L R E E V S F R V G L H E Y P V G S
AGGCTCCACAGATTGGTCCCCCTTGCAAAACCCCTCTGAGAGAGGAAGTGTCTTCAGAGTGGGACTGCATGAGTATCCCGTCGGCTCC

HepC1a #66
V V P S Q M E T K L I T W G A D T A A C G D I I N G L P V S
GTGTCTTCTCCAGATGGAGACAAAGCTCATCACATGGGAGCCGATACCGCTGCCCTGTGGCGATATCAATACGGACTGCCTGTGTCC

HepC1a #79
L L C P A G H A V G I P R A A V C T R G V A K A V D F I P V
CTGCTCTGCCCTGCCGACACGCTGTGGGAATCTTTAGGGCTGCCGCTGTCACAAGGGGAGTGGCTAAGGCTGTGGATTTCATTCCCGTC

HepC1a #113
C V V I V G R I V L S G K P A I I P D R E V L Y R E F D E M
TGCGTGTGATTGTGGGAAGGATTGTGTCTCAGCGGAAAGCCTGCCATTATCCCTGACAGAGAGGTCTGTATAGGGAATTCCGATGAGATG

HepC1a #139
P C T P L P A P N Y T F A L W R V S A E E Y V E I R R V G D
CCCTGTACCCCTCTGCCTGCCCTTAACATACCTTTGCCCTCTGGAGAGTGTCCGCGAAGAGTATGTGGAAATCAGAAGGTCGGCGAT

HepC1a #174
A L Y D V V S K L P L A V M G S S Y G F Q Y S P G Q R V E F
GCCCTCTACGATGTGGTCAGCAAAGTCCCTCTGGCTGTGATGGGCTCCAGCTATGGCTTTCAGTATAGCCCTGGCCAAAGGTCGAGTTT

HepC1a #57
I S W C L W W L Q Y F L T R V E A Q L H V W V P P L N V R G
ATCTCCTGGTGTCTGTGGTGGCTCCAGTATTTCCTCACCAGAGTGGGAAGCCCACTGCATGTGTGGGTGGCTCCCTCAACGTCAGGGGA

HepC1a #51
E N L V I L N A A S L A G T H G L V S F L V P P C F A W Y L
GAGAATCTGGTCATCTCAACGCTGCCCTCCCTGGCTGGCACACAGGACTGGTCAGCTTCTGGTCTTCTTTGCTTTGCTGGTACCTC

HepC1a #193
L P P I I Q R L H G L S A F S L H S Y S P G E I N R V A A C
CTGCCTCCCATTTACCAAAGGCTCCACGGAAGTGTCCGCTTTAGCCTCCACTCCTACTCCCCCGGAGAGATTAAACAGAGTGGCTGCCCTGT

HepC1a #154
N P P L V E T W K K P D Y E P P V V H G C P L P P P R S P P
AACCCCTCCCTCGTGGAAACCTGGAAGAAACCCGATTACGAACCCCTGTGGTCCACGGATGCCCTCTGCCTCCCTTAGGTCCCCCTCT

HepC1a #48
G V G S S I A S W A I K W E Y V V L L P L L L A D A R V C S
GGCGTGGCTCCAGCATTCCTCTGGGCTATCAAATGGGAATACGTGTCTCTGTTTCTGCTCCTGGCTGACGCTAGGGTCTGCTCC

HepC1a #37
L N N T R P P L G N W F G C T W M N S T G F T K V C G A P P
CTGAATAACCAAGGCTCCCTCCGGCAATTGGTTTGGCTGTACCTGGATGAATAGCACAGGCTTTACCAAAGTGTGTGGCGCTCCCTCT

HepC1a #185
P T E A M T R Y S A P P G D P P Q P E Y D L E L I T S C S S

Figure 26 (Cont)

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TTCACAGAGGCTATGACAAGGTATAGCGCTCCCCCTGGCGATCCCCCTCAGCCTGAGTATGACCTCGAGCTCATCACAAGCTGTAGCTCC

HepCla #54

W P L L L L L L A L P Q R A Y A L D T E V A A S C G G V V L
TGGCCTCTGCTCCTGCTCCTGCTCGCCCTCCCCCAAAGGCTTACGCTCTGGATACCGAAGTGGCTGCTCCTCGGAGGCGCTGCTGCTC

HepCla #70

Q Q T R G L L G C I I T S L T G R D K N Q V E G E V Q I V S
CAGCAAACAGAGGCTCCTGGGATGCATTATCACAAGCCTCACCGGAAGGGATAAGAATCAGGTCGAGGGAGAGGTCCAGATTGTGTCC

HepCla #82

S S P P A V P Q S F Q V A H L H A P T G S G K S T K V P A A
AGCTCCCCCTGCGCTCCCCCAAAGCTTTAGGTCGCCCATCTGCATGCCCTACCGGAAGCGGAAAGTCCACCAAAGTGCCTGCGCT

HepCla #104

N T P G L P V C Q D H L E F W E G V F T G I T H I D A H P L
AACAACCCGACTGCTGTGTGTGAGGATCACCTCGAGTTTGGGAAGGCGTCTTCACAGGCCCTCACCCATATCGATGCCCATTTCTCTC

HepCla #26

V L L L F A G V D A E T H V T G G N A G R T T S G L V S L L
GTGCTCCTGCTCTCGCTGGCGTGACCGCTGAGACACAGTCACCGGAGGCAATGCCGAAGGACAACCTCCGGCCTCGTGTCCCTGCTC

HepCla #110

E V T L T H P V T K Y I M T C H S A D L E V V T S T W V L V
GAGGTACCCCTACCCATCCCGTCACCAAATACATTATGACATGCATGAGCGCTGACCTCGAGGTGCTGACAAGCACATGGGTCTCTGGTC

HepCla #56

V G L M A L T L S P Y Y K R Y I S W C L W W L Q Y F L T R V
GTGGGACTGATGGCCCTCACCTCAGCCCTTACTATAAGAGATACATTAGCTGGTGCTCTGGTGGCTGCAATATCTTCTGACAAGGGTC

HepCla #197

A I C G K Y L F N W A V R T K L K L T P I A A A G R L D L S
GCCATTTGCGGAAAGTATCTGTTAACTGGGCGCTCAGGACAAAGCTCAAGCTCACCCCTATCGCTGCCGCTGGCAGACTGGATCTGTCC

HepCla #25

I A Y F S M V G N W A K V L V V L L L F A G V D A E T H V T
ATCGCTTACTTTAGCATGGTGGGAACTGGGCCAAAGTGCTCGTGGTCTGCTCCTGTTTGCCGGAGTGGATGCCGAAACCCATGTGACA

HepCla #147

R L A R G S P P S M A S S S A S Q L S A P S L K A T C T A N
AGGCTCGCCAGAGGCTCCCCCTAGCATGGCTCCAGCTCCGCTCCAGCTCAGCGCTCCCTCCCTGAAAGCCACATGCACAGCCAAT

HepCla #52

G L V S F L V F F C P A W Y L K G R W V P G A V Y A L Y G M
GCCCTCGTGTCTCTCTGTTTCTGTTTCGCTTGGTATCTGAAAGGCAGATGGGTCCCCGGAGCCGCTCTACGCTCTGTATGGCATG

HepCla #145

Q L P C E P E P D V A V L T S M L T D P S H I T A E A A G R
CAGCTCCCTGTGAGCCTGAGCCTGAGCTGCGCTCTGACAGCATGCTGACAGACCTAGCCATATCACAGCGAAGCCGCTGGCAGA

HepCla #171

D S V T P I D T T I M A K N E V F C V Q P E K G G R K P A R
GACTCCGTGACACCCATTGACACAACCATATGGCTAAGAAATGAGGTCTTCTGTGTGCAACCCGAAAAGGGAGGCAGAAAGCCTGCCAGA

HepCla #84

Y A A Q G Y K V L V L N P S V A A T L G F G A Y M S K A H G
TACGCTGCCAAGGCTATAAGGTCTGGTCTGAATCCCTCGTGGCTGCCACACTGGGATTGGAGCCTATATGTCCAAGGCTCACGGA

HepCla #14

V R N S T G L Y H V T N D C P N S S I V Y E A A D A I L H T
GTGAGAACTCCACCGGACTGTATCAGCTACCAATGACTGTCCCAATAGCTCCATCGTCTACGAAGCCGCTGACGCTATCTCCACACA

HepCla #175

S S Y G F Q Y S P G Q R V E F L V Q A N K S K K T P M G F S
AGCTCCTACGGATTCCAATACTCCCCCGACAGAGAGTGGAATTCCTCGTGCAAGCCTGGAAGTCCAAGAAAACCCCTATGGGATTCTCC

HepCla #67

D T A A C G D I I N G L P V S A R R G R E I L L G P A D G M
GACACAGCGCTTGGGAGACATTATCAATGGCCTCCCCGTACGCGCTAGGAGAGGCAGAGAGATTCTGCTCGGCCCTGCCGATGGCATG

HepCla #148

S Q L S A P S L K A T C T A N H D S P D A E L I E A N L L W
AGCCAACTGTCCGCCCTAGCCTCAAGGCTACCTGTACCGCTAACCATGACTCCCCGATGCCGAACTGATTGAGGCTAACCTCCTGTGG

Figure 26 (Cont)

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HepCla #120

N P A I A S L M A F T A A V T S P L T T S Q T L L F N I L G.
AACCCTGCCATTGCCTCCCTGATGGCCTTTACCGCTGCGGTCACTCCCCCTCACCACAAGCCAAACCTCCTGTTTAACATTCTGGGA

HepCla #176

L V Q A W K S K K T P M G F S Y D T R C F D S T V T E S D I
CTGGTCCAGGCTTGGAAAAGCAAAAAGACACCCATGGGCTTTAGCTATGACACAAGGTGTTTCGATAGCACAGTGACAGAGTCCGACATT

HepCla #152

D E R E I S V P A E I L R K S R R F A Q A L P V W A R P D Y
GACGAAAGGAAATCTCCGTGCTGCGGAAATCCTCAGGAAAAGCAGAAGGTTTGCCCAAGCCCTCCCCGTCTGGGCTAGGCCTGACTAT

HepCla #190

M P A P T L W A R M I L M T H F P S V L I A R D Q L E Q A L
ATGTTTGCCCTACCTCTGGGCTAGGATGATCCTCATGACACACTTCTCTCCGTGCTCATCGCTAGGGATCAGCTCGAGCAAGCCCTC

HepCla #96

S V I P T S G D V V V V A T D A L M T G Y T G D F D S V I D
AGCGTCATCCCTACCTCGGGGATGTGGTGTGGTCCGACAGAGCGCTCTGATGACCGGATACACAGGCGATTTCGATAGCGTCATCGAT

HepCla #94

C H S K K K C D E L A A K L V A L G I N A V A Y Y R G L D V
TGCCATAGCAAAAAGAAATGCGATGAGCTGCGCGTAAGCTCGTGGCTCTGGGAATCAATGCGCTCGCTATTACAGAGGCTCGAGCTG

HepCla #46

V L P C S F T T L P A L S T G L I H L H Q N I V D V Q Y L Y
GTGCTCCCTGTAGCTTTACCACTGCTGCCCTCAGCACAGGCGCTCATCCATCTGCATCAGAAATATCGTTCGACGTCCAGTATCTGTAT

HepCla #53

K G R W V P G A V Y A L Y G M W P L L L L L L A L P Q R A Y
AAGGGAAGGTGGGTGCTGCGGCTGTGTATGCCCTCTACGGAATGTGGCCCTCTGCTCTGCTCTGGCTCTGCTCTAGAGAGCCTAT

HepCla #87

S P I T Y S T Y G K F L A D G G C S G G A Y D I I I C D E C
AGCCCTATCATACTCCACCTATGGCAAATCTCTGCGGATGGCGGATGCTCGGGCGGAGCCTATGACATTATCATTTGCGATGAGTGT

HepCla #196

A R S V R A R L L A R G G R A A I C G K Y L F N W A V R T K
GCCAGAAGCGTCAGGGCTAGGCTCCTGGCTAGGGGAGGCAGAGCCGCTATCTGTGGCAAATACCTCTTCAATTGGGCTGTGAGAACCAAA

HepCla #170

K A V A H I N S V W K D L L E D S V T P I D T T I M A K N E
AAGGCTGTGGCTCATTAACTCCGTGTGGAAGGATCTGCTCGAGGATAGCGTCACCCCTATCGATACCAATCATGGCCAAAAACGAA

HepCla #35

F T P S P V V V G T T D R S G A P T Y S W G A N D T D V F V
TTCACACCTCCCCGTGCTGGTGGGCAACCGATAGGTCCGGGCTCCACATACTCTGGGGAGCCAATGACACAGACGTCTTCGTC

HepCla #16

P G C V P C V R E G N A S R C W V A N T P T V A T R D G K L
CCCGATGCGTCCCTGTGTGAGAGAGGAAACGCTAGCAGATGCTGGGTGGCTATGACACCCACAGTGGCTACCAGAGACGGAAGCTC

HepCla #183

Q D C T M L V C G D D L V V I C E S A G V Q E D A A S L R A
CAGGATTGCACAATGCTCGTGTGGCGATGACCTCGTGGTCACTGTGAGTCCGCCGAGTGCAAGAGGATGCGGCTAGCCTCAGGGCT

HepCla #125

V A G A L V A F K I M S G E V P S T E D L V N L L P A I L S
GTGGCTGGGCTCTGGTGGCTTTAAGATTATGTCCGGCGAAGTGCTAGCACAGAGGATCTGGTCAACCTCCTGCCTGCCATTCTGTCC

HepCla #177

Y D T R C F D S T V T E S D I R T E B A I Y Q C C D L D P Q
TAGGATACAGATGCTTTGACTCCACGTCACCGAAAGCGATATCAGAACCGAAGAGGCTATCTATCAGTGTTCGATCTGGATCCGCAA

HepCla #103

E L T P A E T T V R L R A Y M N T P G L P V C Q D H L E P W
GAGCTCACCCCTGCCGAAACACAGTGAGACTGAGAGCCTATATGAATACCCCTGGCCTCCCGTCTGCCAAGACCATCTGGAATCTCTGG

HepCla #186

P Q P E Y D L E L I T S C S S N V S V A H D G A G K R V Y Y
CCCCAACCCGAATACGATCTGGAACCTGATTACCTCTGCTCCAGCAATGTGTCGGTGGCTCAGGATGGCGCTGGCAAAAGGCTACTAT

Figure 26 (Cont)

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HepC1a #9
L G K V I D T L T C G F A D L M G Y I P L V G A P L G G A A
CTGGGAAAGGTCATCGATACCTCACCTGTGGCTTTGCCGATCTGATGGGCTATATCCCTCTGGTCGGCGCTCCCTCGGCGGAGCCGCT

HepC1a #93
A I P L E V I K G G R H L I F C H S K K K C D E L A A K L V
GCCATTCCCTCGAGGTCATCAAAGGCGGAAGGCATCTGATTTCTGTCACTCCAAGAAAAGTGTGACGAACCTGGCTGCCAAACTGGTC

HepC1a #112
G Q V L A A L A A Y C L S T G C V V I V G R I V L S G K P A
GGCGGAGTGTCTGGCTGTGGCTATTTGCCCTCAGCACAGGCTGTGTGGTCATCGTCGGCAGAATCGTCTGTCCGGCAAACCCGCT

HepC1a #184
C E S A G V Q E D A A S L R A P T E A M T R Y S A P P G D P
TGCGAAGCGCTGGCGTCCAGGAAGACGCTGCCTCCCTGAGAGCCTTTACCGAAGCCATGACCAGATACTCCGCCCTCCCGGAGACCCT

HepC1a #199
G W F T A G Y S G G D I Y H S V S H A R P R W F W F C L L L
GGCTGGTTACAGCCGGATACCTCCGGCGGAGACATTTACCATAGCGTCAGCCATGCCAGACCAGATGGTTTTGGTTTTGCCTCCTGCTC

HepC1a #158
S S S T S G I T G D N T T T S S E P A P S G C P P D S D A E
AGCTCCAGCACAGCGGAATCACAGCGGATAACACAACCAAGCTCCGAGCCTGCCCTAGCGGATGCCCTCCCGATAGCGATGCCGAA

HepC1a #100
R T Q R R G R T G R G K P G I Y R F V A P G E R P S G M F D
AGGACACAGAGAAGGGGAAGGACAGGCAGAGGCAACCCGGAATCTATAGGTTTTGTGGCTCCCGGAGAGAGACCTCCGGCATGTTGAT

HepC1a #43
V R M Y V G G V E H R L E A A C N W T R G E R C D L E D R D
GTGAGAATGTATGTGGGAGGCGTGCAGCATAGGCTCGAGGCTGCTGTAACTGGACCAGAGGCGAAAGGTGTGACCTCGAGGATAGGGAT

HepC1a #58
E A Q L H V W V P P L N V R G G R D A V I L L M C V V H P T
GAGGCTCAGTCCACGTCGGGTCCCCCTCTGAATGTGAGAGGCGGAAGGGATGCCGTCATCCTCCTGATGTGGCTCGTCATCCCACA

HepC1a #4
L G V R A T R K T S E R S Q P R G R R Q P I P K A R R P E G
CTGGGAGTGAGGCCACAGGAAACCTCCGAGAGAAGCCAACCCAGAGGCAGAAGGCAACCCATTCCCAAAGCCAGAGGCGCTGAGGGA

HepC1a #187
N V S V A H D G A G K R V Y Y L T R D P T T P L A R A A W E
AACGTGAGCTGCGCCATGACGGAGCGCGGAAGAGAGTGTATTACCTCACCAGAGACCTACCAACCCCTCGCCAGAGCCGCTTGGGAA

HepC1a #159
S E P A P S G C P P D S D A E S Y S S M P P L E G E P G D P
AGCGAACCCGCTCCCTCGGCTGTCCCCCTGACTCCGAGCGTGAAGTCTACTCCAGCATGCCCTCTGGAAGGCGAACCCGAGACCT

HepC1a #63
I G G H Y V Q M A I I K L G A L T G T Y V Y N H L T P L R D
ATCGGAGGCCATTACGTCCAGATGGCCATTATCAAACCTGGGAGCCCTCACCGGAACCTATGTGTATAACCATCTGACACCCCTCAGGGAT

HepC1a #126
P S T E D L V N L L P A I L S P G A L V V G V V C A A I L R
CCCTCCACCGAAGACCTCGTGAATCTGCTCCCCGCTATCCTCAGCCCTGGCGCTCTGGTCTGGGAGTGGTCTGCGCTGCCATTCTGAGA

HepC1a #24
I L D M I A G A H W G V L A G I A Y P M V G N W A K V L V
ATCCTCGACATGATCGCTGGCGCTCACTGGGGCGTCTGGCTGGCATTGCCCTATTCTCCATGGTCGGCAATTGGGCTAAGGCTCCTGGTC

HepC1a #7
E G C G W A G W L L S P R G S R P S W G P T D P R R R S R N
GAGGGATGCGGATGGGCTGGCTGGCTCAGCCCTAGGGGAAGCAGACCTCCTGGGACCCACAGACCTAGGAGAAGGTCCAGGAAT

HepC1a #21
W T T Q G C N C S I Y P G H I T G H R M A W D M M M N W S P
TGGACAACCAAGGCTGTAACTGTAGCATTACCTTGGCCATATCACAGGCCATAGGATGGCTGGGACATGATGATGAACCTGGAGCCCT

HepC1a #17
W V A M T P T V A T R D G K L P A T Q L R R H I D L L V G S
TGGGTGCCATGACCCCTACCGTCGCCACAAGGGATGGCAAACCTGCCCTGCCACAGCTCAGGAGACACATTGACCTCCTGGTGGCTCC

HepC1a #42

Figure 26 (Cont)

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R L W H Y P C T I N Y T I F K V R M Y V G G V E H R L E A A
AGGCTCTGGCATTACCCCTTGACAATCAATTACACAATCTTTAAGGTCAGGATGTACGTCGGCGGAGTGAACACAGACTGGAAGCCGCT

HepC1a #172

V F C V Q P E K G G R K P A R L I V F P D L G V R V C E K M
GTGTTTTGCGTCCAGCCTGAGAAAGGCGGAAGGAAACCCGCTAGGCTCATCGTCTTCCCTGACCTCGGCGTCAGGGTCTGCGAAAAGATG

HepC1a #10

M G Y I P L V G A P L G G A A R A L A H G V R V L E D G V N
ATGGGATACATTCCCTCGTGGGAGCCCTCTGGGAGGCGCTGCCAGAGCCCTCGCCATGGCGTCAGGGTCTGGAAGACGGAGTGAAT

HepC1a #27

G G N A G R T T S G L V S L L T P G A K Q N I Q L I N T N G
GGCGGAAACGCTGGCAGAACCACAAGCGGACTGGTCAGCCTCTGACACCCGGAGCCAAACAGAATATCCAAGTATTACACAAACCGA

HepC1a #13

L A L L S C L T V P A S A Y Q V R N S T G L Y H V T N D C P
CTGGCTCTGCTCAGCTGTCTGACAGTGCCTGCCTCCGCTATCAGGTCAGGAATAGCACAGGCTCTACCATGTGACAAACGATTGCCCT

HepC1a #71

G R D K N Q V E G E V Q I V S T A A Q T F L A T C I N G V C
GCAGAGACAAAACCAAGTGGAAAGGGAAGTGCAAAATCGTCAGCACAGCCGCTCAGACATTCTCGCCCATGCATTAAACGGAGTGTGT

HepC1a #18

P A T Q L R R H I D L L V G S A T L C S A L Y V G D L C G S
CCCCGTACCCAAGTGAAGGCATATCGATCTGCTCGTGGGAAGCGCTACCCCTCTGCTCCGCCCTCTACGTCCGCGATCTGTGTGGCTCC

HepC1a #83

H A P T G S G K S T K V P A A Y A A Q G Y K V L V L N P S V
CAGCTCCACAGGCTCCGGCAAAAGCACAAAGTCCCGCTGCCTATGCGGCTCAGGGATACAAAGTGTGCTGCTCAACCCCTAGCGCT

HepC1a #6

R T N A Q P G Y P W P L Y G N E G C G W A G W L L S P R G S
AGGACATGGGCTCAGCCTGGCTATCCCTGGCCCTCTACGGAAACGAAGGCTGTGGCTGGGCGGATGGCTCCTGTCCCCCAGAGGCTCC

HepC1a #162

T E D V V C C S M S Y S W T G A L / V T P C A A E E Q K L P I
ACCGAAGAGCTGTGTGTGCTCCATGTCTACTCTGGACAGGCGCTCTGGTCACCCCTTGGCGCTGCGAAGAGCAAAAGCTCCCCATT

HepC1a #55

A L D T E V A A S C G G V V L V G L M A L T L S P Y Y K R Y
GCCCTCGACACAGAGGTCCCGCTAGCTGTGGCGGAGTGGTCTGGTGGGCTCATGGCTCTGACACTGTCCCCCTATTACAAAGGTAT

HepC1a #38

W M N S T G F T K V C G A P P C V I G G A G N N T L H C P T
TGGATGAATCCACCGATTCAAAAGGTCTGCGGAGCCCTCCCTGTGTGATTGGCGGAGCGGAAACAATACCTCCACTGTCCACACA

HepC1a #168

S V E E A C S L T P P H S A K S K F G Y G A K D V R C H A R
AGCGTCGAGGAAGCCTGTAGCCTCACCCCTCCCATAGCGCTAAGTCCAAGTTTGGCTATGGCGCTAAGGATGTGAGATGCCATGCCAGA

HepC1a #119

I S G I Q Y L A G L S T L P G N P A I A S L M A P T A A V T
ATCTCCGGCATTCAATATCTGGCTGGCCTCAGCACACTGCCTGGCAATCCCGCTATCGCTAGCCTCATGGCTTTCACAGCCGCTGTGACA

HepC1a #3

Q I V G G V Y L L P R R G P R L G V R A T R K T S E R S Q P
CAGATTGTGGGAGGCGCTACCTCTGCTAGGAGAGGCCCTAGGCTCGGCGTCAGGGCTACCAGAAAGACAAGCGAAAGGTCCAGCCT

HepC1a #194

L H S Y S P G E I N R V A A C L R K L G V P P L R A W R H R
CTGCATAGCTATAGCCCTGGCGAAATCAATAGGGTCGCGCTTGCTCAGGAACTGGGAGTGCTCCCTCAGGGCTTGGAGACACAGA

HepC1a #189

T A R H T P V M S W L G N I I M F A P T L W A R M I L M T H
ACCGTAGGCATACCCCTGTGAATAGCTGGCTGGGAAACATTATCATGTTGCTCCACACTGTGGGCCAGAATGATTCTGATGACCCAT

HepC1a #81

E N L E T T M R S P V F T D N S S P P A V P Q S F Q V A H L
GAGAACTCGGAAACCAATGAGAAGCCCTGTGTTTACCGATAACTCCAGCCCTCCCGCTGTGCTCAGTCTTCCAAGTGGCTCACCTC

HepC1a #91

A T P P G S V T V P H P N I E E V A L S T T G E I P F Y G K

Figure 26 (Cont)

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GCCACACCCCTGGCTCCGTGACAGTGCCTCACCCCTAACATTGAGGAAGTGGCTCTGTCCACACAGGCGAAATCCCTTTCTATGGCAAA

HepCla #60

L V F D I T K L L L A V F G P L W I L Q A S L L K V P Y F V
CTGGTCTTCGATATCAAAAGCTCCTGCTCGCCGTCTTGGACCCCTCTGGATTCTGCAAGCCTCCCTGCTCAAGGTCCCTATTTCGTC

HepCla #23

T A A L V M A Q L L R I P Q A I L D M I A G A H W G V L A G
ACCGTGCCTCGTGATGGCCCACTGCTCAGGATTCCCAAGCCATTCTGGATATGATTGCCGGAGCCCATTTGGGGAGTGCTCGCCGGA

HepCla #98

C N T C V T Q T V D F S L D P T F T I E T T T L P Q D A V S
TGCAATACCTGTGTGACACAGACAGTGGATTCTCCCTGGATCCCAATTTCACAAATCGAAACCAACCCCTCCCAAGACGCTGTGTCC

HepCla #109

H G P T P L L Y R L C A V Q N E V T L T H P V T K Y I M T C
CACGGACCCACACCCCTCCTGTATAGGCTCGGCGCTGTGCAAAACGAAGTGACACTGACACACCCCTGTGACAAAGTATATCATGACCTGT

HepCla #179

A R V A I K S L T E R L Y V G G P L T N S R G E N C G Y R R
GCCAGAGTGGCTATCAAAAGCCTCACGAAAGGCTCTACGTGGCGGACCCCTACCAATAGCAGAGGCGAAACTGTGGCTATAGGAGA

HepCla #39

C V I G G A G N N T L H C P T D C F R K H P E A T Y S R C G
TGCGTCATCGGAGGCGCTGGCAATAACACTGCAATTGCCCTACCGATTGCTTTAGGAAACACCCCTGAGGCTACCTATAGCAGATGCGGA

HepCla #76

T C G S S D L Y L V T R H A D V I P V R R R G D S R G S L L
ACCTGTGCTCCAGCGATCTGTATCTGGTACCAGACAGCTGACGTCTCCCTGTGAGAAGGAGGCGATAGCAGAGGCTCCCTGTCTC

HepCla #138

N M W S G T P P I N A Y T T G P C T P L P A P N Y T F A L W
AACATGTGCTCGGCACATTCCTATCAATGCCTATACCAAGGCCCTTGACACCCCTCCCGCTCCCAATTACACATTGCTCTGTGG

HepCla #89

H S T D A T S I L G I G T V L D Q A E T A G A R L V V L A T
CACTCCACCGATGCCACAAGCATTCTGGGAATCGGAACCGTCTGGATCAGGCTGAGACAGCCGAGCCAGACTGGTCTGTCTGCCACA

HepCla #130

Y V P E S D A A A R V T A I L S S L T V T Q L L R R L H Q W
TACGTCCCGAAAGCGATGCGCTGCCAGAGTGACAGCCATTCTGTCCAGCCTCACCGTCACCCACTGCTCAGGAGACTGCATCAGTGG

HepCla #8

R P S W G P T D P R R R S R N L G K V I D T L T C G F A D L
AGGCTAGCTGGGGCCTACCGATCCAGAAGGAGAAGCAGAAACCTGGCAAGTGATTGACACACTGACATGCGGATTGCTGACCTC

HepCla #33

G P D Q R P Y C W H Y P P K P C G I V P A K S V C G P V Y C
GGCCTGACCAAGGCTTACTGTGGCATTACCTCCCAACCTGTGGCATTGTGCTGCCAAAAGCGTCTGCGGACCCGCTACTGT

HepCla #115

E E C S Q H L P Y I E Q G M M L A E Q P K Q K A L G L L Q T
GAGGAATGCTCCACGATCTGCCTTACATTGAGCAAGGCATGATGCTCGCGAACAGTTTAAGCAAAAGGCTCTGGGACTGCTCCAGACA

HepCla #107

Y Q A T V C A R A Q A P P P S W D Q M W K C L I R L K P T L
TACCAAGCCACAGTGTGTGCCAGAGCCCAAGCCCTCCCTTAGCTGGGACCAATGTGGAAGTGTCTGATTAGGCTCAAGCCTACCTC

HepCla #34

C G I V P A K S V C G P V Y C F T P S P V V V G T T D R S G
TGCGGAATCGTCCCGCTAAGTCCGTGTGTGGCCCTGTGTATTGCTTTACCCCTAGCCCTGTGGTCTGTGGGAACACAGACAGAAAGCGGA

HepCla #131

S S L T V T Q L L R R L H Q W I S S E C T T P C S G S W L R
AGCTCCCTGACAGTGACACAGCTCCTGAGAAGGCTCCACCAATGGATTAGCTCGAGTGTACCACACCTGTAGCGAAGCTGGCTGAGA

HepCla #161

D L S D G S W S T V S S E A G T E D V V C C S M S Y S W T G
GACCTCAGCGATGGCTCCTGGTCCACCGTCAGCTCGAGGCTGGCAGAGGATGTGGTCTGCTGTAGCATGAGCTATAGCTGGACCGGA

HepCla #108

W D Q M W K C L I R L K P T L H G P T P L L Y R L G A V Q N
TGGGATCAGATGTGGAATGCCTCATCAGACTGAAACCCACACTGCATGGCCCTACCCCTCTGCTCTACAGACTGGGAGCCGTCAGAAT

Figure 26 (Cont)

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HepCla #116

L A E Q F K Q K A L G L L Q T A S R Q A E V I A P A V Q T N
CTGGCTGAGCAATTCAAACAGAAAGCCCTCGGCCTCCTGCAAAACCGCTAGCAGACAGGCTGAGGTGATCGCTCCCGCTGTGCAAAACCAAT

HepCla #118

W Q K L E V F W A K H M W N F I S G I Q Y L A G L S T L P G
TGGCAAAAGCTCGAGGTCTTCTGGGCCAAACACATGTGGAATTTTCATTAGCGGAATCCAATACCTCGCCGGACTGTCCACCTCCCGGA

HepCla #129

L I A F A S R G N H V S P T H Y V P R S D A A A R V T A I L
CTGATTGCCCTTGCTCCAGGGGAAACATGTGTCCCCACACACTATGTGCTGAGTCCGAGCGTCCCGCTAGGGTCACCGCTATCCTC

HepCla #19

A T L C S A L Y V G D L C G S V F L V G Q L F T F S P R R H
GCCACATGTGTAGCGCTCTGTATGTGGGAGACCTCTGCGGAAGCGTCTTCTCGTGGGACAGCTCTTCAATTCTCCCCCAGAAGGCAT

HepCla #102

S S V L C E C Y D A G C A W Y E L T P A E T T V R L R A Y M
AGCTCCGTGCTCTGCGAATGCTATGACGCTGGCTGTGCCTGGTACGAACCTGACACCGCTGAGACAACCGTCAGGCTCAGGGCTTACATG

HepCla #122

G W V A A Q L A A P G A A T A F V G A G L A G A A I G S V G
GGCTGGGTGGCTGCCCAACTGGCTGCCCTGGCGCTGCCACAGCCTTTGTGGGAGCCGGACTGGCTGGCGCTGCCATTGGCTCCGTGGGA

HepCla #29

S W H I N S T A L N C N E S L N T G W L A G L F Y Q H K F N
AGCTGGCACATTAACCTCCACCGCTCTGAATTGCAATGAGTCCCTGAATACCGGATGGCTCGCCGGACTGTTTTACCAACACAAATTCAT

HepCla #164

N A L S N S L L R H H N L V Y S T T S R S A C Q R Q K K V T
AACGCTCTGTCCAACCTCCCTGTCTAGGCATCACAATCTGGTCTACTCCACCACAAGCAGAAGCGCTTGCCAAAGGCAAAAGAAAGTGACA

HepCla #1

A A M S T N P K P Q R K T K R N T N R R P Q D V K F P G G G
GCGCTATGTCCACCAATCCCAACCCCAAGGAAAACCAAAAGGAATACCAATAGGAGACCCCAAGACGTCAAGTTTCCCGGAGGCGGA

HepCla #106

S Q T K Q S G E N F P Y L V A Y Q A T V C A R A Q A P P P S
AGCCAAACCAACAGTCCCGCGAAAACCTTCCCTATCTGGTCCGCTATCAGGCTACCGTCTGGCTAGGGCTCAGGCTCCCCCTCCCTCC

HepCla #36

A P T Y S W G A N D T D V F V L N N T R P P L G N W F G C T
GCCCCATCTATAGCTGGGGCGCTAACGATACCGATGTGTTTGTGCTCAACAATACCAGACCCCTCTGGGAAACTGGTTCCGATGCACA

HepCla #156

V P P P R K K R T V V L T E S T L S T A L A E L A T K S F G
GTGCTCCCCCTAGGAAAAGAGAACCGTGTGCTCACCGAAAGCACACTGTCCACCGCTCTGGCTGAGCTCGCCACAAAGTCCTTGGGA

HepCla #165

S T T S R S A C Q R Q K K V T F D R L Q V L D S H Y Q D V L
AGCACAACTCCAGTCCGCTGTCTAGAGACAGAAAAGGTACCTTTGACAGACTGCAAGTGTCTGACTCCCACTATCAGGATGTGCTC

HepCla #90

D Q A E T A G A R L V V L A T A T P P G S V T V P H P N I E
GACCAAGCCGAAACCGCTGGCGCTAGGCTGTGGTCTCGGCTACCGCTACCCCTCCCGGAAGCGTCACCGTCCCCCATCCCAATATCGAA

HepCla #141

F H Y V T G M T T D N L K C P C Q V P S P E F F T E L D G V
TTCCATTACGTACCGGAATGACAACCGATAACCTCAAGTGTCCCTGTCTAGGTCCCTCCCGGAATTCCTTACCGAACTGGATGGCGTC

HepCla #198

L K L T P I A A A G R L D L S G W F T A G Y S G G D I Y H S
CTGAACTGACACCCATTGCGCTGCGGAAGGCTCGACCTCAGCGGATCGTTTACCGCTGGCTATAGCGGAGGCGATATCTATCACTCC

HepCla #117

A S R Q A E V I A P A V Q T N W Q K L E V F W A K H M W N F
GCCTCCAGGCAAGCCGAAGTGATTGCCCTCGCGTCCAGACAAACTGGCAGAACTGGAAGTGTTTTGGGCTAAGCATATGTGGAACCTT

HepCla #181

C R A S G V L T T S C G N T L T C Y I K A R A A C R A A G L
TGCAGAGCCTCCGGCGTCTGACAACCTCTGCGGAAACACACTGACATGCTATATCAAAGCCAGAGCCGCTTGCAGAGCCGCTGGCCTC

Figure 26 (Cont)

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HepCla #166

F D R L Q V L D S H Y Q D V L K E V K A A A S K V K A N L L
T T G A T A G G C T C C A G G T C C T G G A T A G C C A T T A C C A A G A C G T C C T G A A A G A G G T C A A G G C T G C C G C T A G C A A A G T G A A A G C C A A T C T G C T C

HepCla #180

G P L T M S R G E N C G Y R R C R A S G V L T T S C G N T L
G C C C T C T G A C A A A C T C C A G G G G A G A G A A T T G C G G A T A C A G A A G G T T A G G G C T A G C G G A G T G C T C A C C A C A A G C T G T G G C A A T A C C C T C

HepCla #136

I M H T R C H C G A E I T G H V K M G T M R I V G P R T C R
A T C A T G C A C A A A G G T G T C A C T G T G G C G C T G A G A T T A C C G G A C A C G T C A A G A A T G G C A A T G A G A A T C G T G G C C C T A G G A C A T G C A G A

HepCla #144

E V S F R V G L H E Y P V G S Q L P C E P E P D V A V L T S
G A G T C A G C T T T A G G G T C G G C C T C C A C G A A T A C C C T G T G G G A A G C C A A C T C C C T G C G A A C C G A A C C G A A T G T G G C T G T G C T C A C C T C C

HepCla #167

K E V K A A A S K V K A N L L S V E E A C S L T P P H S A K
A A G A A G T G A A A G C C G C T G C C T C C A A G G T C A A G G C T A A C C T C C T G T C C G T G G A A G A G G C T T G C T C C C T G A C A C C C C C T A C T C C G C C A A A

HepCla #59

G R D A V I L L M C V V H P T L V P D I T K L L L A V F G P
G G C A G A G A C G C T G T G A T T C T G C T C A T G T G T G G T C C A C C C T A C C C T C G T G T T G A C A T T A C C A A A C T G C T C C T G G C T G T G T T T G G C C C T

HepCla #146

M L T D P S H I T A E A A G R R L A R G S P P S M A S S S A
A T G C T C A C G A T C C C T C C C A C A T T A C C G C T G A G G C T G C C G G A A G G A G A C T G G C T A G G G A A G C C C T C C C T C C A T G G C T A G C T C C A G G C T

HepCla #78

S P R P I S Y L K G S S G G P L L C P A G H A V G I F R A A
A G C C C T A G G C C T A T C T C T A C C T C A A G G A A G C T C C G G C G A C C C C T C C T G T G T C C C G C T G G C C A T G C C G T C G G C A T T T C A G A G C C G C T

HepCla #32

D F D Q G W G P I S Y A N G S G P D Q R P Y C W H Y P P K P
G A C T T T G A C C A A G G C T G G G G C C C T A T C C T A C G C T A A C G G A A G C G G A C C C G A T C A G A G A C C C T A T T G C T G G C A C T A T C C C C T A A G C C T

HepCla #128

R H V G P G E G A V Q W M N R L I A F A S R G N H V S P T H
A G G C A T G T G G G A C C C G A G A G G G A G C C G T C C A G T G G A T G A A T A G G C T C A T C G C T T T G C T A G C A G A G G C A A T C A C G T C A G C C C T A C C C A T

HepCla #50

C L W M M L L I S Q A E A A L E N L V I L N A A S L A G T H
T G C C T C T G G A T G A T G C T C C T G A T T A G C C A A G C C G A A G C C G C T C T G G A A A C C T C G T G A T T C T G A A T G C C G C T A G C C T G C C G G A A C C C A T

HepCla #114

I I P D R E V L Y R E F D E M E E C S Q H L P Y I E Q G M M
A T C A T T C C C G A T A G G G A A G T G C T C T A C A G A G A T T T G A C G A A A T G G A A G A G T G T A G C C A A C A C C T C C C C T A T A T G A A C A G G G A A T G A T G

HepCla #47

L I H L H Q W I V D V Q Y L Y G V G S S I A S W A I X W E Y
C T G A T T C A C C T C C A C C A A A C A T T G T G G A T G T G C A A T A C C T C T A C G G A G T G G G A A G C T C C A T C G C T A G C T G G G C C A T T A A G T G G G A G T A T

HepCla #200

V S H A R P R W F W F C L L L L A A G V G I Y L L P N R A A
G T G C C C A G C T A G G C C T A G G T G G T T C G T T C T G T C T G C T C C T G C C G C T G G C G T G G C A T T A C C T C C T G C C T A A C A G A G C C G C T

HepCla #85

A A T L G F G A Y M S K A H G I D P N I R T G V R T I T T G
G C G C T A C C C T C G G C T T T G G C C T T A C A T G A C A A G C C C A T G G C A T T G A C C C T A A C A T T A G G A C A G G C G T C A G G A C A A T C A A C A C G G A

HepCla #62

R V Q G L L R I C A L A R K M I G G H Y V Q M A I I K L G A
A G G G T C C A G G G A C T G C T C A G A A T T T G C G C T C T G G C T A G G A A A A T G A T T G G C G G A C A C T A T G T G C A A A T G G C T A T C A T T A A G C T C G G C G C T

HepCla #153

R R F A Q A L P V W A R P D Y N P P L V E T W K K P D Y E P
A G G A G A T T C G C T C A G G C T C T G C C T G T G T G G G C C A G A C C C G A T T A C A A T C C C C C T C T G G T C G A G A C A T G G A A A A G C C T G A C T A T G A G C C T

HepCla #72

T A A Q T F L A T C I N G V C W T V Y H G A G T R T I A S P
A C C G C T G C C C A A A C C T T T C T G G C T A C C T G A T C A A T G G C G T C T G C T G G A C C G T C A C C A T G G C G C T G G C A C A A G G A C A A T C G C T A G C C C T

HepCla #65

Figure 26 (Cont)

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W A H N G L R D L A V A V E P V V F S Q M E T K L I T W G A
TGGGCTCACAATGGCCTCAGGGATCTGGCTGTGGCTGTGGAAACCGTCGTGTTAGCCAAATGGAAACCAAAGTATTACCTGGGGCGCT

HepCla #74

K G P V I Q M Y T N V D Q D L V G W P A P Q G S R S L T P C
AAGGACCCGTCATCCAAATGTATACCAATGTGGATCAGGATCTGGCTGGCCGCTCCCAAGGCTCAGGTCCCTGACACCCCTGT

HepCla #151

K V V I L D S F D P L V A E E D E R R I S V P A E I L R K S
AAGTGTGTGATTCTGGATAGCTTTGACCCCTCTGGTCGCGAAGAGGATGAGAGAGAGATTAGCGTCCCGCTGAGATTCTGAGAAAGTCC

HepCla #64

L T G T Y V Y N H L T P L R D W A H N G L R D L A V A V E P
CTGACAGGCACATACGTCTACAATCACCTCACCCCTCTGAGAGACTGGGCCCATAACGGACTGAGAGACCTGCGCGTGGCGTGGAGCCT

HepCla #80

V C T R G V A K A V D F I P V E N L E T T M R S P V F T D N
GTGTGTACAGAGGCGTCGCCAAGCCGTCGACTTTATCCCTGTGGAAAACCTCGAGACAACCATGAGGTCCCGCTCTTCACAGACAAAT

HepCla #95

A L G I N A V A Y Y R G L D V S V I P T S G D V V V V A T D
GCCCTCGGCATTAAACGCTGTGGCTTACTATAGGGGACTGGATGTGTCCGTGATCCCAACAGCGGAGAGCTGCTGGTGTGGCTACCGAT

HepCla #111

M S A D L E V V T S T W V L V G G V L A A L A A Y C L S T G
ATGTCGCGCATCTCGAAGTGGTCACCTCCACCTGGGTGCTCGTGGGAGGCGTCTGGCTGCCCTCGCCGCTTACTGTCTGTCCACCGGA

HepCla #97

A L M T G Y T G D F D S V I D C N T C V T Q T V D F S L D P
GCCCTCATGACAGGCTATACCGGAGACTTTGACTCCGTGATTGACTGTAAACATGCGTCAACCAAAACCGTCGACTTTAGCCTCGACCCCT

HepCla #2

N T N R R P Q D V K F P G G G Q I V G G V Y L L P R R G P R
AACACAAACAGAAGGCCCTCAGGATGTGAAATCCCTGGCGGAGGCCAATCGTCGGCGGAGTGTATCTGCTCCCAAGAGGGGACCCAGA

HepCla #11

R A L A H G V R V L E D G V N Y A T G N L P G C S P S I F L
AGGGCTCTGGCTCAGCGAGTGAGAGTGCTCGAGGATGGCGTCAACTATGCCACAGGCAATCTGCCTGGCTGTAGCTTTAGCATTTTCTCTC

HepCla #169

S K F G Y G A K D V R C H A R K A V A H I N S V W K D L L E
AGCAATTCGGATACGGAGCCAAAGAGCTCAGGTGTACGCTAGGAAAGCCGTCGCCCATATCAATAGCGTCTGGAAAGACCTCCTGGAA

HepCla #28

T P G A K Q N I Q L I N T W G S W H I N S T A L N C N E S L
ACCCCTGGCGCTAAGCAAAACATTACAGCTCATCAATACCAATGGCTCCTGGCATATCAATAGCACAGCCCTCAACTGTAAACGAAAGCCTC

HepCla #30

N T G W L A G L F Y Q H K F N S S G C P E R L A S C R R L T
AACACAGGCTGGCTGGCTGGCTCTTCTATCAGCATAAGTTAACTCCAGCGGATGCCCTGAGAGACTGGCTAGCTGTAGGAGACTGACA

HepCla #49

V V L L F L L L A D A R V C S C L N M M L L I S Q A E A A L
GTGGTCTGCTCTTCTCTGCTCGCGGATGCCAGAGTGTGTAGCTGTCTGTGGATGATGCTGCTCATCTCCAGGCTGAGGCTGCCCTC

HepCla #192

D C E I Y G A C Y S I E P L D L P P I I Q R L H G L S A P S
GACTGTGAGATTACGGAGCCTGTTACTCCATCCGAACCCCTCGACCTCCCCCTATCATTGAGAGCGCATGGCCTCAGCGCTTTCTCC

HepCla #73

W T V Y H G A G T R T I A S P K G P V I Q M Y T N V D Q D L
TGGACAGTGTATACCGAGCCGGAACCAACCATTCCTCCCCAAAGGCCCTGTGATTGAGATGTACACAAACGTGACCAAGACCTC

HepCla #101

Y R F V A P G E R P S G M P D S S V L C E C Y D A G C A W Y
TACAGATTCTGTCGCCCTGGCGAAAGCCCTAGCGGAATGTTGACTCCAGCGTCTGTGTGAGTGTACGATGCCGATGCGCTTGGTAT

HepCla #45

R S E L S P L L L S T T Q W Q V L P C S P T T L P A L S T G
AGGTCGAGCTCAGCCCTCTGCTCTGTCCACACACAGTGGCAGGTCTGCCTTGCCTTCAACCCCTCCCCGCTCTGTCCACCGGA

HepCla #195

L R K L G V P P L R A W R H R A R S V R A R L L A R G G R A

Figure 26 (Cont)

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CTGAGAAAGCTCGGCGTCCCCCTCTGAGAGCCTGGAGGCATAGGCTAGGTCCTGAGAGCCAGACTGCTCGCCAGAGGCGGAAGGGCT

HepC1a #121

S P L T T S Q T L L F N I L G G W V A A Q L A A P G A A T A
AGCCCTCTGACAACCTCCAGACACTGCTCTTCAATATCCTCGGCGGATGGTTCGCGCTCAGCTCGCGCTCCCGAGCCGCTACCGCT

HepC1a #61

L W I L Q A S L L K V P Y F V R V Q G L L R I C A L A R K M
CTGTGGATCCTCCAGGCTAGCCTCCTGAAAGTGCTTACTTTGTGAGAGTGCAAGGCTCCTGAGAATCTGTGCCCTCGCCAGAAAGATG

HepC1a #137

V K N G T M R I V G P R T C R N M W S G T F P I N A Y T T G
GTGAAAAAGGAAACCATGAGGATTGTGGGACCCAGAACCTGTAGGAATATGTGGAGCGGAACCTTTCCATTAAACGCTTACACAACCGGA

HepC1a #92

E V A L S T T G E I P F Y G K A I P L E V I K G G R H L I F
GAGGTGCGCCTCAGCAACCGGAGAGATTCCCTTTTACGGAAGGCTATCCCTCTGGAAGTGATTAAGGGAGGCAGACACCTCATCTTT

HepC1a #188

L T R D P T T P L A R A A W E T A R H T P V N S W L G N I I
CTGACAAGGGATCCCAACCCCTCTGGCTAGGGCTGCCTGGGAGACAGCCAGACACACCGTCAACTCCTGGCTCGGCAATATCAT

HepC1a #140

R V S A E E Y V E I R R V G D P H Y V T G M T T D N L K C P
AGGGTCAGCGCTGAGGAATACGTGAGATTAGGAGAGTGGGAGACTTTCACTATGTGACAGGCATGACCACAGACAATCTGAAATGCCCT

HepC1a #155

P V V H G C P L P P P R S P P V P P P R K K R T V V L T E S
CCCGTGTGCTATGGCTGTCCCTCCCTCCCTCCAGAGCCCTCCCGTCCCTCCCTCCAGAAAGAAAAGGACAGTGGTCTGACAGAGTCC

HepC1a #157

T L S T A L A E L A T K S F G S S S T S G I T G D N T T T S
ACCTCAGCAGCCCTCGCCGAAGTGGCTACCAAAAGCTTTGGCTCCAGCTCCACCTCCCGCATTACCGGAGACAATACCAACCTCC

HepC1a #135

V S C Q R G Y K G V W R G D G I M H T R C H C G A E I T G H
GTGTCTCTGCCAAAGGGATACAAAGGCGTCTGGAGAGGCGATGGCATTATGCATACAGATGCCATTGCGGAGCCGAAATCACAGGCCAT

HepC1a #20

V F L V G Q L F T F S P R R H W T T Q G C N C S I Y P G H I
GTGTTTCTGGTGGCCAACTGTTTACCTTTAGCCCTAGGAGACACTGGACCACAGGGATGCAATTGCTCCATCTATCCCGGACACTT

HepC1a #123

F V G A G L A G A A I G S V G L G K V L V D I L A G Y G A G
TTCTGCGGCTGCGCTCGCGGAGCGCTATCGGAAGCGTCCGCTCCGCAAGTGCTCGTGGATATCCTGCGCGGATACGGAGCCGGA

HepC1a #133

D I W D W I C E V L S D F K T W L K A K L M P Q L P G I P P
GACATTTGGGATTGGATTTCGGAAGTGCTCAGCGATTTCAAAACCTGGCTGAAAGCCAACTGATGCCCAACTGCCTGGCATTCCCTTT

HepC1a #15

N S S I V Y E A A D A I L H T P G C V P C V R E G N A S R C
AACTCCAGCATTTGTATGAGGCTGCCGATGCCATTCTGCATACCCCTGGCTGTGTGCCCTGCGTCAGGGAAGGCAATGCCCTCCAGGTGT

HepC1a #31

S S G C P E R L A S C R R L T D F D Q G W G P I S Y A N G S
AGCTCGGCTGTCCCGAAAGGCTCGCTCCTGCAGAAGGCTCACCGATTTCGATCAGGGATGGGGACCCATTAGCTATGCCAATGGCTCC

HepC1a #178

R T E E A I Y Q C C D L D P Q A R V A I K S L T E R L Y V G
AGGACAGAGGAAGCCATTTACCAATGCTGTGACCTCGACCCCTCAGGCTAGGGTCGCCATTAACTCCCTGACAGAGAGACTGTATGTGGGA

HepC1a #69

V S K G W R L L A P I T A Y A Q Q T R G L L G C I I T S L T
GTGTCCAAGGGATGGAGACTGCTCGCCCTATCAGACCTATGCCCAACAGACAAGGGGACTGCTCGGCTGTATCATTACCTCCCTGACA

HepC1a #191

P F S V L I A R D Q L E Q A L D C E I Y G A C Y S I E P L D
TTCCTTAGGCTCTGATTGCCAGAGACCAACTGGAACAGGCTCTGGATTGGAAATCTATGGCGCTTGCTATAGCATTGAGCCTCTGCAT

HepC1a #142

C Q V P S P E F F T E L D G V R L H R F A P P C K P L L R E
TGCCAAGTGCTTAGCCCTGAGTTTTCACAGAGCTCGACGGAGTGAGACTGCATAGGTTTGGCCCTCCCTGTAAGCCTCTGCTCAGGGAA

Figure 26 (Cont)

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HepCla #182

T C Y I K A R A A C R A A G L Q D C T M L V C G D D L V V I
ACCTGTTACATTAAAGGCTAGGGCTGCCTGTAGGGCTGCCGACTGCAAGACTGTACCATGCTGGTCTGCGGAGACGATCTGGTGGTGATT

HepCla #86

I D P N I R T G V R T I T T G S P I T Y S T Y G K F L A D G
ATCGATCCCAATATCAGAACCGGAGTGAGAACCATTAACACAGGCTCCCCATTACCTATAGCACATACGGAAAGTTTCTGGCTGACCGA

HepCla #44

C N W T R G E R C D L E D R D R S E L S P L L L S T T Q W Q
TGCAATTGGACAAAGGGAGAGAGATGCGATCTGGAAGACAGAGACAGAAGCGAATGTCCCCCTCTGCTCAGCACAAACCAATGGCAA

HepCla #22

T G H R M A W D M M M N W S P T A A L V M A Q L L R I P Q A
ACCGGACACAGAATGGCTTGGGATATGATGATGAATTGGTCCCCACAGCCGCTCTGGTCATGGCTCAGCTCCTGAGAATCCCTCAGGCT

HepCla #127

P G A L V V G V V C A A I L R R H V G P G E G A V Q W M N R
CCCGAGCCCTGGTGGTGGCGCTGCTGTGCGGCTATCCTCAGGAGACAGTCCGCCCTGGCGAAGGCGCTGTGCAATGGATGAACAGA

HepCla #149

H D S P D A E L I E A N L L W R Q E M G G N I T R V E S E N
CAGGATAGCCCTGACGCTGAGCTCATCGAAGCCAATCTGCTCTGGAGACAGGAATGGGAGGCAATATCACAAGGGTCGAGTCCGAGAAT

HepCla #105

E G V F T G L T H I D A H F L S Q T K Q S G E N F P Y L V A
GAGGGAGTGTTTACCGGACTGACACACATTGACGCTCCTTTCTGTCCCAGACAAAGCAAAGCGGAGAGAATTTCCCTTACCTCGTGGCT

HepCla #5

R G R R Q P I P K A R R P E G R T W A Q P G Y P W P L Y G N
AGGGGAAGGAGACACCTATCCCTAAGGCTAGGAGACCCGAAGGCAGAACCTGGGCCCAACCCGGATACCTTGGCCTCTGTATGGCAAT

HepCla #173

L I V F P D L G V R V C E K M A L Y D V V S K L P L A V M G
CTGATTGTGTTTCCCGATCTGGGAGTGAGAGTGTGTGAGAAAATGGCTCTGTATGAAGTCTGTCCAAGCTCCCCCTCGCCGTCATGGGA

HepCla #12

Y A T G N L P G C S F S I F L L A L L S C L T V P A S A Y Q
TAGCGTACCGGAAACCTCCCGGATGCTCCTTCTCCATCTTTCTGTGCGCCCTCCTGTCTGCTCAGCGTCCCGCTAGCGCTTACCAA

HepCla #124

L G K V L V D I L A G Y G A G V A G A L V A F K I M S G E V
CTGGGAAAGTCTGGTGGACATCTGGCTGGCTATGGCGCTGGCGTGGCCGAGCCCTGCTGGCTTTCAAAATCATGAGCGGAGAGGTC

HepCla #160

S Y S S M P P L E G E P G D P D L S D G S W S T V S S E A G
AGCTATAGCTCCATGCCCTCCCTCGAGGGAGAGCCTGGGATCCCGATCTGTCCGACGGAAGCTGGAGCACAGTGTCCAGCGAAGCCGGA

HepCla #150

R Q E M G G N I T R V E S E N K V V I L D S F D P L V A E E
AGGCAAGAGATGGGCGGAAACATTACAGAGTGGAAGCGAAACAAAGTGGTCACTCGACTCCTTCGATCCCTCGTGGCTGAGGAA

HepCla #75

V G W P A P Q G S R S L T P C T C G S S D L Y L V T R H A D
GTGGGATGGCCTGCCCTCAGGGAAGCAGAAGCCTCACCCCTTGACATGCGGAAGCTCCGACCTCTACCTCGTGACAAGGCATGCCGAT

HepCla #88

G C S G G A Y D I I I C D E C H S T D A T S I L G I G T V L
GGCTGTAGCGGAGGCGCTTACGATATCATTATCTGTGACGAATGCCATAGCACAGACGCTACCTCCATCCTCGGCATTGGCACAGTGCTC

HepCla #99

T F T I E T T T L P Q D A V S R T Q R R G R T G R G K P G I
ACCTTTACCATTTAGACAAACCACTGCCTCAGGATGCCGTGAGCAGAACCCAAAGGAGAGGCAGAACCGGAAGGGGAAAGCCTGGCATT

HepCla #40

D C F R K H P E A T Y S R C G S G P W I T P R C L V D Y P Y
GACTGTTTCAGAAAGCATCCCGAAGCCACATACTCCAGGTGTGGCTCCGGCCCTTGGATTACCCCTAGGTGTCTGGTGGACTATCCCTAT

HepCla #201

L A A G V G I Y L L P N R A A
CTGGCTGCCGAGTGGGAATCTATCTGCTCCCCAATAGGGCTGCC

Figure 26 (Cont)

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HepCla #163

A L V T P C A A E E Q K L P I N A L S N S L L R H H N L V Y
GCCCTCGTGACACCTGTGCGGCTGAGGAACAGAACTGCCTATCAATGCCCTCAGCAATAGCCTCCTGAGACACCATTAACCTCGTGTAT

HepCla #132

I S S E C T T P C S G S W L R D I W D W I C E V L S D F K T
ATCTCCAGCGAATGCACAAACCTTGTCTCGGCTCCTGGCTCAGGATATCTGGGACTGGATCTGTGAGGTCTGTCCGACTTTAAGACA

HepCla #134

W L K A K L M P Q L P G I P F V S C Q R G Y K G V W R G D G
TGGCTCAAGGCTAAGCTCATGCCCTCAGCTCCCGGAATCCCTTTCTGTCAGCTGTGACAGAGGCTATAAGGGAGTGTGGAGGGGAGACGGA

HepCla #41

S G P N I T P R C L V D Y P Y R L W H Y P C T I N Y T I P K
AGCGGACCTCGATCACACCCAGATGCCTCGTGGATTACCTTACAGACTGTGGCACTATCCCTGTACCATTAACATATACCATTTTCAA

Artificial Protein:

VI PVRRRGDSRGSLLSPRIISYLKSGSGGPARRGREILLGADGMVSKGWRLLAPITAYARLHRFAPCKPFLRREBVSFRVGLHEYFVGSVVFQMET
KLITWGADTAACGDIINGLPSVLLCPAGHAVGIFRAAVCTRGVAKAVDFIPVCVIVGRIVLSGKPAIIPDREVLRYEPDEMPCTPLPAPNYTFALWR
VSAKEYVEIRRVGDALYDVVSKPLAVMGSYSGFYSPGQRFVEFISWCLNWLQYFLTRVEAQLHVWVPLNVRGENLVIINAASLAGTHGLVSFLVFP
CFAWYLLPPIIQRLHGLSAPSLASYSFGEINRVAACNPFLVBTWKKPDYEPFVVRHGCPLPPRSPPGVGSSIASNAIKWEYVVLFLLLADARVCSLN
NTRPPLGNWFGCTWMTSTGFTKVCAGAPPTEAMTRYSAAPGDPPOPEYDLELITSCSSWPLLLLLLALPQRAYALDTEVAASCGGVVLQQTGRLLGCI
ITSLTGRDNQVGEVQIVSSSPFAVPQSPQVAHLHAPTGSCKSTKVPAANTPGLPVCQDHLFEWEGVPTGLTHIDAHFLVLFLPAGVDAETHVTGDN
AGRTTSGLVSLLEVLTHPTVKYIMTCHSADLEVVTSTWVLVGLMALTLSPYKYRIYISWCLNWLQYFLTRVAICGKYLFWNAVRTKLKLPILAAAGR
LDLSIAYFSHVGMARVLLVLLPAGVDAETHVTRLARGSPSSMASSASQSLAPSLLKATCTANGLVSVLVFPFCFAMYLKGRWVPGAVYALYGMQLPC
BEPPOVAVLTSMITDPSHITACAGRDSVTPIDTTIMAKNEVFCVQPEKGRKPARYAAQGYKVLVLPVSAATLPGFAYMSKAGHVRNSTGLYHVTN
DCPNSSIVYEAADAILHTSSYGFQYSPGQRFVFLVQAWKSKKTPMGFSDTAACGDIINGLPSVARRGREILLGADGMSQLSAPSLKATCTANHDSFD
AELIEMLLMNPALIASLMAPTAAVTSPLTTSQTLFPNIGLVQAWKSKKTPMGFSDTRCFDSTVTESDIDEREISVPAEILKRSRRPAQALPVWARP
DYMPTATLWARMILMTHFPVSVLIARDQLEQALSVIPTSGDVVVVATDALMTGYTGDPDSVIDCHSKKCCDELAACKLVALGINAVAYRGLDVLVPCSP
TTLPALSTGLIHLHQNIVDVQYLYKGRWVPGAVYALYGMWPLLLLLLALPQRAYSPITYSTYKFLADGGCSCGAYDIIICDECAVSVRARLLARGGR
AAICGKYLFWNAVRTKKAHAINSVKDLLEDVTPIDTTIMAKNEBTPSPVVVGTTRDSGAPTYSWGANDTDVFPVGCVPVCREGNASRCNVAMTPT
VATRDGKLQDCTMLVCGDLDVVICESAGVQEDAAASLRAVAGALVAFKIMSGEVSTEDLVNLLPAILSYDTRCFDSTVTESDIETBEAIYQCCDLDPQ
ELTPAETTVRLRAYMTTGLPVCQDHLFPNQPEYDLELITSCSSNVSAHDGAGKRVYLLGKVITDLTCGPADLMGYIPLVGAPLGGAAAIPLBVIK
GGRHLIPCHSKKCCDELAACKLGGVLAALAAAYCLSTGCVVIVGRIVLSGKPACESAGVQEDAAASLRAFTTEAMTRYSAAPGDPGNFTAGYSGGDIYHSV
SHARPRNFWPCLLLSSSTSGITGDNITTSSEPAFSGCPCPDSDAERTQRRGTGRGKPGIYRFPVAPGERFSGMFDVRMYVGGVEHRLBAACWTRGERC
DLEDRDEAQLHVVWPLNVRGRDAVILMVCVHPTLGVRAIRKTSERSQPRGRQPIPKARRPBGVNSVAHDGAGKRVYLLTRDPTPLARAAWSE
PAPSGCPDSDAESYSSMPLBEGEPDPIGGHYVQMAIKLALGTGYVYVNHLPRLDRPSTEDLVNLLPAILSPGALVGVVCAAILRLILDMLAGAHW
GVLAGIAYFSMVGMNAKVLVECGNAGNLLSPRGSFSPNGFTDPRRRSRNMTTQGCNCISIYPGHIIGHRMANDMNNWSFWVAMTPTVATRDGKLPA
QLRRHIDLLVGSRLMHPCTINITYIKVRMYVGGVEHRLBAAVFCVQPEKGRKPARLIVPDLGVVRCEKMGYIPLVGAPLGGAAALAHAGVRVLE
GDVWGGWAGRTTSGLVSLTPCAKQNIQLINTGLALLSCLTVPASAYQVRNSTGLYHVTNDCPGRDNQVGEVQIVSTAAQITFLATCINGVCPATQ
LRRHIDLLVGSATLCSALYVGDLCGSHAFTGSGKSTKVPAAYAAQGYKVLVLPVSVRTWAQPGYFWPLYGNEGCGNAGNLLSPRGSSTEDVCCSMSYS
WTGALVTPCAABEQKLPALDTEVAASCGGVVLVGLMALTLSPYKYRYWNSSTGFTKVCAGAPPCVIGGAGNMTLHCPTSVREACSLTPPHSAKSKPGY
GAKDVRCHARISGIIYLAGLSTLPGNPAIASLMAPTAAVTQIVGGVYLLPRRGVRLGVRAIRKTSERSQPLHSYSPGEINRVAACLRKLGVPPLRAWR
HRTARHTPVNSWLGMIIMPATLWARMILMTHENLETMRSFVFTDMSSPFAVPQSPQVAHLATPFGSVTVPHNIEBEVALSTTGBIPFYKGLVFDIT
KLLAVFGPLNIIQASLLKVPYFVTAALVMAQLLRIPOAILDMLAGAHWGLAGCNTCVTQTVDFSLDPTFTIETTTLPODAVSHGPTPLLYRLGAVQ
NEVTLTHPTVTKYIMTCHSADLEVVTSTWVLVGLMALTLSPYKYRYWNSSTGFTKVCAGAPPCVIGGAGNMTLHCPTDPRKHPEATYSRCGTGSSDLSDGSWSTVSEAGT
GDSRGSLLMWSGTFPIINAYTTGPTCLPAPNYTFALNHSTDATSLIGIGTVLDQAEATAGARLVVLAITYVPESDAAARVTAISSLITVQTLLRRLHQW
RPSNGPTDPRRRSRMLGKVIDTLTCGPADLGDQRPYCNHYPKPGCIPVPAKSVCGPVYCECSQHLPIYIQQGMLABQFKQALGLLQTYQATVCAR
AQAPPPSNDQNNKCLIRLKPCLGIVPAKSVCGPVYCTPSPVAVGTDRSGSSLTVTQLLRRLHQWISSECTTPCSGSLWRLSDGSWSTVSEAGT
EDVVCCSMSYSWTGDMQNNKCLIRLKPCLGIVPAKSVCGPVYCECSQHLPIYIQQGMLABQFKQALGLLQTYQATVCAR
LSTPLGLIAPASRGNHVSPTHTVPESDAAARVTAIATLCSALYVGDLCGSPVLVGLQFTPSPRRHSSVLCEBYDAGCANYELTPAETTVRLRAYMGW
VAAQLAAPGAATAFVAGLAGAAIGSVGSHINSTALNCNESLNTGMLAGLFTQHKFNALSNLLRHHNLVYSTTSRSACQKQKVTAAMSTNPKPQ
RKTRKNTNRPPQDVKFPGGGSKTQSGEMFPYLVAQATVCARAQAPPSPATYSWGANDTDVFLNTRPPLGNWFGCTVPPRKRKRTVVLTSTLS
TALABLATKSPGSTTSRSACQKQKVTFDRLQVLDVSHYQVLDQAEATAGARLVVLAITYPPGSVTVPHNIEBHYVTGHTTDLNLCPCQVPSPEFFTE
LDGVVLKLPILAAAGRLDLSGWTAGYSGGDIYHSASRQAEVIAPAVQTNWQKLEVFNAJHMWNPISGIIYLAG
QVLDVSHYQVLDKEVKAASKVKANLLGPLTNSRGENCYRRCRASGVLTTSCGNTLIMHTRCHCGABITGHVONGTMRIVGPRTCREVSFRVGLHEYF
VGSQLPCEPEPOVAVLTSTKEVKAASKVKANLLSVEEACSLTPPHSAKGRDAVILMVCVHPTLVFDITKLLAVFGPMLTDPHITAEAGRRRLARG
SPSSMASSASPRPIISYLKSGSGGPLLCPAGHAVGIFRAADFDQGWGPISYANGSGFDQRPYCNHYPKPRHVGPGEGAVQMMRLIAPASRGNHVS
THCLMMLLLISQAEALBNLVIINAASLAGTHIIPDREVLRYEPDEMEBCSQHLPIYIQQGMLIHLHQNIVDVQYLYGVGSSIASNAIKWEYVSHARP
RNPWFCLLLLAAGVGIIYLLPNRAAAATLPGFAYMSKAGIDPHIRTGVRTITTRGVQGLLRICALAROMIGGHYVQMAIKLGAARRPAQALPVNARPD
YNPPLVBTWKKPDYBPTAAQTFLATCINGVMTVYHAGTRTIASPWAHNGRLDLAVAVEPVVFSQMETKLITWGAGFVIQMYTNVDQDLVGNPAPQ
GSRSLTPCKVYILDSFPLVAREDEREISVPAEILKRSLTGTYYVNHLPRLDMAHNGRLDLAVAVEPVCTRGVAKAVDFIPVENLETMRSPVFTDN
ALGINAVAYRGLDVSVPITSGDVVVVATDMSADLEVVTSTWVLVGLMALTLSPYKYRYWNSSTGFTKVCAGAPPCVIGGAGNMTLHCPTDPRKHPEATYSRCGTGSSDLSDGSWSTVSEAGT
VKFPGGGQIVGGVYLLPRRGPRRALAHGVRLVEDGVNATGNLPGCSPSIFLSKFGYGAQDVRCHARKAVAHINSVWDLLETGKAKQNIQLINTGS
WHINSTALNCNESLNTGMLAGLFTQHKFNALSNLLRHHNLVYSTTSRSACQKQKVTAAMSTNPKPQ
GLSAPSWTVYHAGTRTIASPFGPIVQMYTNVDQDLRYFVAPGERPSGWFSSVLCEBYDAGCANYRSELSPLLLSTTQWQVLPSCFTPLPALSTGLR
KLGVLPPLRAWRRHARSVRARLLARGGRASPLTTSQTLFPNIGLVQAWKSKKTPMGFSDTRCFDSTVTESDIDEREISVPAEILKRSRRPAQALPVWARP
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VTGHTTDLNLCPCPVVHGCPLPPRSPFPVPPPRKRTVVLTSTLSALABLATKSPGSSSTSGITGDNITTSVSCQRYKGVWVRGDGIMHTRCHCGAB
ITGHVILVGLQFTPSPRRHWTQGCNCISIYPGHIIPVAGLAGAAIGSVGLGVLDVLAGYAGAGIDWDICEVLSDFKTWKLAKMLPQLGPIPFNSSI
VYEAADAILHTPGCVPRVREGNASRCSGCPERLASCRRLTDFDQGWGPISYANGSRTEBAIYQCCDLQARVAIKSLTERLYGVGSKWRLLPQIT
AYAQQTRGLLGCIITSLTFFSVLIARDQLEQALDCEIYGACYSIBLPDQVPSPEFFTELOGVRLHRFAPCKPFLRRETCYIKARAACRAAGLQDCTM

Figure 26 (Cont)

LVCDDLVV I IDPNIRITGVRTITTTGSPITYSTYKGFLADGCNMTRGERCOLEDNRDRSELSPLLLSTTQWQTGHRMADMMNNWSPTAALVMAQLLRIP
QAPCALVVGVCVCAALILRRHVPGGEGAVQWNNRHS DPABLEIANLLWRQEMGNGNITRVSENEGVFTGLTHIDAHFLSQTQSGENFPYLVARGRRQP
IPKARRPGRRTMAQPGYPNWFLGNLIVFPDLGVRVCBMAJLVDPVSKLPAVMGYATGNLPGCSFSIFLLALLSCLVTPASAYAQGLKVLVDI LAGYA
GVAGALVAPKMSGEVSYSSMPLECGPDGDLSDSGWSTVSSEAGRGNGNITRVSENKVVIDLSDPDLVAEEVGNPAQGRSLRTPCTCGSSDL
YLVTRHADCGSGGAYDIIICDECHSTDATSILIGITGLVTFITETTLTPQDAVSRTRQRRGRTGRGKPGIDCPRKHPEATYSRCGSGPWITPRCLVDYPY
LAAGVGIGYLLPWRAALVTPCAAEQKLPINALSNSLLRRHNLVYISSECTTPCSGSWLRDINDWICVLSLDFNTYLKAKLMPQLPGIPFVSCQRGYK
GVWRGDSGPNWITPRCLVDYPYRLNHWYPTCTFITYIPK

[illegible]

Figure 26 (Cont)

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TCAGGCTCTCGGAAAGATGATGGGATACATTCCCTCTGTGGGAGCCCTCTGGGAGGCGCTGCCAGAGCCCTCGCCCATGGCGTCAGGGTCTTGAA
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CGGACTGGCTCTGCTCAGCTGTCTGACAGTGCCTGCTCCGCTATCAGGTCAAGAAATAGCACAGGCTCTACCATGTGA CAACAGATTGCCCTGGCA
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Figure 26 (Cont)

Cassette A

Figure 26 (Cont)

[illegible]

Cassette B

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GGCTCGGACTGATGATGAATGAGCTGGAGCCCTTGGGTGCGCATGACCCCTACCGTGTCCCAAGGATAGCAAACTCGCTGT
CCACAAGCAGTCCAGAGACACATGACCTCTGCTGGTCCAGGCTTCGCATTTACCTTCACCAATCAATTTACAAATTC
TTTAAAGGTGAGGATGTACGTGCGCGGAGTGGAAACAGAGCTGGAAGCGCTGTGTTTTGCTGCCAGCCTGAGAAAGGCGG
AAGAAACCCCGTAGGCTACATGCTCTCCCTGACCTTCCGCGCTCAGGCTGTGCGAAAGATAGTAGGATACATTTCCCTCTG
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Figure 26 (Cont)

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ACGATTGCCCTGGCAGAGACAAAAACCAAGTGGAGGGGGAAGTGCAATCGTCAGCACAGCGCTCAGACATTCCTCGCC
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Figure 26 (Cont)

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Cassette C

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 cgactgtgagattttagggacctgttactccatogaacccctcgacactccccctatcatctcagagactgcattggcctca
 gcccatttctctgacagtgattatcagggacggccagcagaaaccttgctctccccaaaggccctgtgattctcagattgtac
 acaaagctgtgatacagagactctcagagatttctgtcgccctggcgcaaggccttagcggaatgtttgactctcagcgtctgtg
 tgaagtgtacgatgcccgaatggccttggtataggtccgagctcagccctctgctcctgtgtccaccacacagtgccaggtcc
 tagcttgctctcttcacaaacctcccgctctgtgtccacggactgagaagactcgcgctgccccctctcagagactggagg
 catcgcttaggtctcgtagagacctgactgctgtccagagggcgaaggctagccctctgacaaactccagacactgctct
 cttcaatatctccggcgatgggtcgccgtcagctcgccgtctccggagccgctacagcctctgttgatctccaggcta
 gctctctgaagatgctcttactttgtgagagtgcaaggacctcttgagaattctgtgcccctcgccagaaagatgggtgaaaaac
 ggaaccttagagattgtgggacccagacaactgtgagaaattgtggagcggaaacctttcccaataagcttacaacccgg
 agaggtcgccctcagcacaaacggagagattcccttttagcgaaggctatccctctggaagtgtattagggagggcagac
 actctctcttctgacagagacaccccaacacccctctggcttagggctcgctgggagacagccagacacacacccgtcaac
 tctgtgctcgcccaatatcattaggtcgagctgaggaatagctgcagatttagagagtgaggagactttcactattgtgac
 aggcattgaccacagacaaattgaaatgccctcccgctggtgcatggctgtccccctccccctccacagagccctcccgctcc
 cccctcccgagaagaagaagacagtggtctctgacagagctcacctcagcacagccctcgccgaactgctcatccaaaagg
 ttggctctcagctccaactcgccgatttacggagacaataccacaacctcggtgtctgccaagggtatcaaaaagcgt
 ctggagaggggatggcattatgcataaccagatgccattggggagccgaataacagggccatgtgtttctggtcgcccaac
 tgtttactctttagcccttaggagacactggacacacaggaatgcaattgtgtcattatcccggaacattttgtgtggc
 ctggcctcgcccgagccgctatcggaaagcgtggcctctggcgaagtgtctgttgatattctgtccggaatcaaggcagcgg
 agacatttgggattggatttggaaagtctcaggcatttcaaaacctggctgaaagccaaactgatgccccaaactgcctg
 gcatctcccttttaactccagcatgtgttatggagctgcagatgccattctgcataccctggcgtgtgctgtctgtgctg
 gaaggcaatgctccaggtgtagctcgccgtgtccggaaggcctggcctctgcagaggctcagcgaatttgcattagcagg
 atggggacccatttagctatgccaatggctccaggaacagagggaagccatttaccaatgctgtgacctcgaccctcaggcta
 ggggtggccatttaagtctctcagacagagactgtatgtggggagtgtccagaggttagagagactgctgcgcccttatcagaccg
 tatggccacnagacagggagctgctggctgtatctattacctctctgacatttttagcgtctgatttggcagagacaa
 acttggaacaggctctggatttggcaaatctatggcgcttgctatagcatttgagcctctggatttgcaagtgccttagccctg
 agttttctcagagcctcagcagagctgagactgcatagtgttggccctccctgtgaagcctctgctcagggaaaagctgttat
 attaaagcttaggcctgctcttagggctgcggagctcgaagactgtacatacgtgctgtcgcgagacatctgtgctgtgat
 tatcgatcccaatatcagaacccgagtgagaaccatttaccacaggctcccccatattacctatagcacatacggaaagtttc
 tgcctgacggcgtcaatttggcaaggggagagagatgcgattctggaagacagacagaaagcgaactgtgccccctctgt
 ctacagacaalcccaattggcacaacggacagaaatggcttgggaatgatagtaatttgcctccccacacccctctgct
 catggctcagctccttgaaattccctcaggctcccgagccctctgtgtcgccgtctgtgtgtgctgctatctctcaggagac
 acgttgcccttgccggagccctgtgcaatggatgaaacagacacagatagccctgaacctgagctcatcgaagcccaattctg
 ctctggagacaggaattggngggcaattcaaaaggctgagctcgagaattggaggagtgtttaccggactgacacacat
 tgagcctcactttctgtgccagacaagcgaaggcgagaaatttcccttacctgtggcttaggggaaggagacagcctta
 tccctaaaggcttaggagaccgagggcagaacctgggcccaccccggaatacccttggcctctgttatggcaattctgattgtg
 ttcccgatctggagagtgagagtggttgagaaaaatggctctgtatgacgtgtgtccaagctccccctcgccgtctcagatggg
 atagcctacggaaaacctcccgagatgctcttctcatctttctgtgtgcccctgtgtgtgtgctgtaccgtgccccgcta
 gogcttaccaaactgggaaggctctgtgtgtgataattctgtgctggctatggggcgtggcgtgcccggagccctctgtgctttc
 aaaaactgagcggagaggtcagctatagcttccattctccccctcgagggagagcctggcgatcccgatctgtcgacgg
 agcctcagacacagtgcttcagcgaagccgaaggacagagatggcggaacattaccagagtggaagcgaagcaaaacaaag
 tgotatctctgactctcttgatccccctgtgtgcttaggaagtgggaatggcctgcccctcagggaacgaagccttcacc
 ctctgacacatgggaagctccgacctctacctctgacaaaggcctgcgagtggctgtaggcggagcgtctacgatcatat
 tattctgtagcaaatgcatacgacacagagcctactcactctcgcatggcatggcacagctcactcttacctattagacaa
 ccacactgctctcagatgtccgtcagcagaccccaaacgagagcgaagacgggaagcctggcatttgactgtttc
 agaaagcatcccgaaagcccatatctcagggtgtggctcgcccttggaattacccttaggtgtctgtgtgataattccata

Figure 26 (Cont)

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AACTGCCTATCAATGCCCTCAGCAATAGCCTCCTGAGACACCATAACCTCGTGTATATCTCCAGCGAATGCACAACCCCT
TGCTCCGGCTCCTGGCTCAGGGATATCTGGGACTGGATCTGTGAGGTCTGTCCGACTTTAAGACATGGCTCAAGGCTAA
GCTCATGCCCTCAGCTCCCGGAATCCCTTTCTCAGCTGTCAGAGAGGCTATAAGGGAGTGTGGAGGGGAGACGGAAGCG
GACCTGGATCACACCCAGATGCCTCGTGGATTACCTTACAGACTGTGGCACTATCCCTGTACCATTAACTATACCATT
TTCAAaagatctTGAgtcgacgaattcgcc

Figure 26 (Cont)

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Melanoma Savine design

Two savines - one containing scrambled melanocyte differentiation Ags
 - one containing scrambled melanoma cancer specific Ags

Genes in melanocyte differentiation Savine**gp100**

MDLVLRKRLHLAVIGALLAVGATKVPNRQDWLGVSRLRTKAWNRLYPWTEAQRDCWRGGQVSLKVSNDGPTLI
 GANASFSIALNFPQSQKVLDPGQVIWVNNIINGSQVWGGQPVYPQETDDACIFPDGGPCPSGSWSQKRSFVYVWKTW
 GQYWQVLGGPVSGLSIGTRAMLGTHMEVTYVYHRRGSRSYVPLAHSSSAFTITDQVPFSVSVSQLRALDGGNKHFLR
 NQPLTFALQLHDPGSGYLAEADLSYTWDFGDSSGTLISRALVVTHTYLEPGPVTAQVVLQAAIPLTSCGSSPVPPTTDC
 HRPTAEAPNTTAGQVPTTEVVGTTPGQAPTAEPSGTTSVQVPTTEVISTAPVQMPTAESTGMTPEKVPVSEVMGTTLA
 EMSTPEATGMTPAEVSIVVLSGTTAAQVTTTEWVETTARELPIPEPEGPDASSIMSTESITGSLGPLLDGTATLRLVK
 RQVPLDCVLYRYGSFVSTLDIVQGIESAEILQAVPSGEGDAFELTVSCQGLPKACMEISSPGCQPPAQRCLCQPVLP
 SPACQLVLHQILKGGSGTYCLNVSLADTNSLAVVSTQLIMPQOEAGLGQVPLIVGILLVLMVAVLASLIYRRRLMKQD
 FSPVQLPHSSSHWLRLPRIFCSCPIGENSPLLSGQQV

MART

MPREDAHFYGYPKKGHGSYTTAEBAAGIGILTIVILGVLILLIGCWYCRRRNGYRALMDKSLHVGTTQCALTRRCPOEG
 FDHRDSKVSLEKNCPEVVPNAPPAYEKLSAEQSPPPYSP

TRP-1

PAFLTWHRHYLLRLEKDMQEMLQEPSFSLPYWNFATGKNVCDICTDDLMGSRSNFDSLISPNSVFSQWRVVCDSLED
 YDTLGTLCNSTEDGPIRRNPAGNVARPMVQRLPEPQDVAQCLEVGLFDTPPFYSNSTNSFRNTVEGYSDPTGKYDPAV
 RSLHNLALHFLNGTGGQTHLSSQDPIFVLLHTFTDAVFDEWLRRYNADISTFPLENAPIGHNRYQNMVFPWPPVTNTE
 MFVTAPDNLGYYE

Tyros

MLLAVLYCLLWSFQTSAGHFPRACVSSKNLMEKECCPPWSGDRSPCGQLSGRGSCQNILLSSNAPLGPQFPFTGVDDRE
 SWPSVFYNRTCQCSGNFMGPNCGNCKPFGWGPNCETERRLLVRRNIFDLSAPEKDKFPAYLTLAKHTISSDYVIPIGTY
 GQMKNGSTPMFNDINIYDLFVWMHYVSMALLGGSBIWRDIDFAHEAPAFPLPWHRLFLLRWEQBIQKLTGDNFTIP
 YDWRDAEKCDICTDEYMGQHPNPNLLSPASFFSSWQIVCSRLEBYNSHQSLCNGTPEGPLRRNPGNHDKSRTPLR
 PSSADVEFCLSLTQYESGSMKKAANFSPRNTLEGFASPLTGIADASQSSMHNLHIYMNGTMSQVQGSANDPIFLLHH
 AFVDSIFEQWLQRHRPLQEVYPEANAPIGHNRESYMPVFIPLYRNGDFFISSKDLGYDYSYLQSDPDSFQDYIKSYL
 EQASRIWSWLLGAAMVCAVLTAALLAGLVSLLCRHKKRQLPEEKQPLLMEKEDYHSLYQSHL

TRP2

MSPLWNGFLLSCLGCKILPGAQQFPRVCMTVDSLNVKECCPRLGAESANVCGSQQGRGQCTEVRADTRPWSGPYILR
 NQDDRELWPKRPFPHRTCKCTGNFAGYNGDCKFGWTGPNCEKPKPVIRQNIHLSLPQEREQFLGALDLAKRVHPDY
 VITTOHWLGLLGPNGTQPFANCSVYDFFVWLHYYSVRDITLLGPRPYRAIDFSGQPAFVTWHRHYLLCLERDLQRL
 IGNESFALPYWNFATGRNECDVCTDQLFGAARPDPTLISRNSRFSSWETVCDLDDYNHLVTLNCTYEGLLRRNQ
 GRNSMKLPTLKDIRDCLSLQKFDNPPFFQNSTFSRPALEGFADKADGTLDSQVMSLHNLVHSFLNGTNALPHSAANDP
 IFVVLHSFTDAIFDEWMKRFNPPADAWPQELAPIGHNRMYNMVPFFPPVTNEELFLTSDQLGYSYIDLFPVSVEETPG
 WPTLLVVMGTLVALVGLFVLLAFLQYRRLRKGYTPLMETHLSSKRYTEEA

MC1R

MAVQSQRRLLGSLNSTPTAIPQLGLAANQTGARCLEVSISDGLFSLGLVSLVENALVVATIAKNRNLHSPMYCFIC
 CLALSDLLVSGTNVLETAIVILLLEAGALVARAAVLQQLDNVIDVITCSSMLSSL CFLGAIADVRIYISIFYALRYHSIV
 TLPRAPRAVAIIVASVVFSTLPIAYYDHVAVLLCLVVFFLAMLVLMVAVLYVHMLARACQHAQGIARLHKRQRPVHQG
 FGLKGAVTLTILLGIFFLCWGPPFLHLTLIVLCEPHPTCGCIPKNFNLFLALIICNAIIDPLIYAFHSQELRRTLKEV
 LTCSSW

MUC1F

MTPGTQSPFFLLLLLVLTVTVTGSGHASSTPGGEKETSATQRSSVPSSTEKNAVSMTSSVLSHSPGSGSSTTQGDV
 TLAPATEPASGSAATWGQDVTSVPVTRPALGSTTPAHDVTSAPDNK

Figure 27

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MUC1R

NRPALGSTAPPVHNVTASAGSASGSASTLVHNGTSARATTTTPASKSTPFSIPSHHSDTPITLASHSTKTDASSTHHSS
 VPPLTSSNHSTSPQLSTGVSFFFLSFHISNLQFNSSLEDPSDYYQELQORDISEMFLQIYKQGGFLGLSNIKFRPGSV
 VVQLTLAFREGTINVHDVETQFNQYKTEAASRYNLTISDVSVSDVPPFSAQSGAGVPGWGIALLLVLCVLVALAIVY
 LIALAVCQCRKNYQQLDIFPARDTYHPMSEYPTYHTHGRYVPPSSSTDRSPYEKVSAGNGGSSLSYTNPAVAAASANL

NB Muc 1 Repeat sequences in the middle of the gene were removed

Genes in melanoma specific Savine

BAGE

MAARAVFLALSAQLLQARLMKEESPVVSWRLEPEDGTALCFIF

GAGE-1

MSWRGRSTYRPRPRRYVEPPMIGPMRPEQFSDEVEPATPEEGEPATQRQDPAAAQEGEGEGASAGQGPKPEADSQEQ
 GHPQTGCECEDGPDGQEMDPPNPPEEVKTPEBEMRSHYVAQTGILWLLMNNCFNLNSPRKP

gp100In4

SWSQKRSPVYVWKTWGEGLPSQPIIHTCVYFPLPDHLSFGRPFHLNFCDFL

MAGE-1

MSLEQRS LHCKPEEALRAQQEALGLVCVQAATSSSSPLVLGTL EEVPTAGSTDP PQSPQGASAFPTTINFTQRQPSE
 GSSSREEEGPSTSCILESIFRAVITKQVADLVGFLLLKYRAREPVTKAEMLESVIKKNYKHCPEIFGKASESLQLVFG
 IDVKEADPTGHSYVLVTCGLSYDGLLDGNQIMPKTGFLIIVLVMIAEGGHAPEEBIWEELSVMEVYDGREHSAYGE
 PRKLLTQDLVQEKYLEYRQVPDSDPARYEFLWGPRALAEYSYVKVLEYVIKVSARVRFPFPPSLREALREEEEGV

MAGE-3

MPLQRSQHCKPEEGLEARGEALGLVGAQAPATEEQEAASSSTLVEVTLGEVPAAESPDPPQSPQGASSLPTTMNYP
 LWSQSYEDSSNQEEEGPSTFPDLSEFQAALS RKVAELVHFLLLKYRAREPVTKAEMLSVVGNGWQYFPFVIFSKASS
 SLQLVFGIELMEVDPIGHLYIFATCLGLSYDGLLDGNQIMPAGLLIIVLAI IAREGDCAPEEKIWEELSVLEVFEGR
 EDSILGDPKLLTQHVFQENYLEYRQVPGSDPACYEFLWGPRALVETS YVKVLHMHVKISGGPHISYPPLEHWVLREG
 EE

PRAME

MERRRLWGS IQSRYISMSVWTS PRRLVELAGQSLLKDEALAI AAELELLPRELFPPLFMAAFDGRHSQTLKAMVQAWPF
 TCLPLGVLMKGQHLHLETFKAVLDGLDVL LAQEVPRPRNKLQVLDLRKNSHQDFWTVWSGNRASLYSPPEPRAAQPMT
 KKRKVDGLSTAEQPFIPVEVLVDLFLKEGACDELFSYLI EKVKRKNVLR LCKKLKIFAMPMDIKMILKMVQLDS
 IEDLEVCTWKLPTLAKPSPYLGQMINLRRLLLSHIHASSYISPEKEEQYIAQFTSQFLSLQCLQALYVDSLFFLRGR
 LDQLLRHVMNPLETSLITNCR LSEGDVMHLSQSPSVS QLSVLSL SGVMLTDVSP EPLQALLERASATLQDLVFDECGI
 TDDQLLALLPSLSHCSQLTTLSFYGNSISISALQSLQLHIGLSNLTHVLYPVPLESYEDIHGTLHLERLAYLHARLR
 ELLCELGRPSMVWLSANPCPHCGDRTFYDPEPILCPCFMPN

TRP2IN2

LMETHLSSKRYTEEAGGFFPWLVVYYRFVIGLRVWQWEVISCKLIK RATTROP

NYNS01a

MQAEGRGTTGGSTGDADGPGGPGIPDGPGGNAGGPGEAGATGGRGPRGAGAARASGPGGGAPRGPHGGAASGLNGCCRC
 GARGPESRLLEFYLPAMPFATPMEAE LARRSLAQDAPPLPVPGVLLKEFTVSGNILTIRLTAADHRQLQLS ISSCLQQL
 SLLMWITQCFLPVFLAQPPSGQRR

NYNS01b

MLMAQEALAF LMAQGAMLAQERRVPRAAEVPGAQGGQGGPRGEEAPRGVRMAARLQG

LAGE1

Figure 27 (Cont)

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MQAEGQGTGGSTGDADGPGGPGIPDGPGGNAGGPGEAGATGGRGPRGAGAAASGPRGGAPRGPHGGAASAQDGRCP
 GARRPDSRLQLHITMPFSSPMEABLVRRIILSRDAAPLPRPGAVLKDFTVSGNLLFIRLTAADHRQLQLSISSCLQQL
 SLLMWITQCFLPVFLAQAPSGQRR

Differentiation Savine Scramble process

Disease name : melanoma
 Input filename : Diffmucg.txt
 Output filename : Diffmucs.txt
 Number genes : 8
 Number segments : 187
 Segment length : 30
 Segment overlap : 15

Segments in original order:

Gene : gp100
 Segment# : 1
 Offset : 1
 1st Codon : 1
 A A M D L V L K R C L L H L A V I G A L L A V G A T K V P R
 GCCGCTATGGATCTGGTCTGAAAGGTGTCTGCTCCACCTCGCCGTCATCGGAGCCCTCTGGCTGTGGGAGCCACAAGGTCCCCAGA

Gene : gp100
 Segment# : 2
 Offset : 16
 1st Codon : 1
 V I G A L L A V G A T K V P R N Q D W L G V S R Q L R T K A
 GTGATTGGCGCTCTGCTCGCCGTGGCGCTACCAAAGTGCTAGGAATCAGGATTGGCTCGGCGTCAGCAGACAGCTCAGGACAAAGGCT

Gene : gp100
 Segment# : 3
 Offset : 31
 1st Codon : 1
 N Q D W L G V S R Q L R T K A W N R Q L Y P E W T E A Q R L
 AACCAAGACTGGCTGGGAGTGTCCAGGCACTGAGAACCAAAGCCTGGAACAGACAGCTCTACCTGAGTGGACCGAAGCCCAAAGGCTC

Gene : gp100
 Segment# : 4
 Offset : 46
 1st Codon : 1
 W N R Q L Y P E W T E A Q R L D C W R G G Q V S L K V S N D
 TGGAATAGGCACTGATCCCAATGGACAGAGGCTCAGAGACTGGATTGCTGGAGGGGAGGCCAAGTGCTCCCTGAAAGTGTCCAAAGAT

Gene : gp100
 Segment# : 5
 Offset : 61
 1st Codon : 1
 D C W R G G Q V S L K V S N D G P T L I G A N A S F S I A L
 GACTGTGGAGAGGCGGACAGGTGAGCCTCAAGGTGAGCAATGACGGACCCACACTGATTGGCGCTAACGCTAGCTTTAGCATTGGCCCTC

Gene : gp100
 Segment# : 6
 Offset : 76
 1st Codon : 1
 G P T L I G A N A S F S I A L N F P G S Q K V L P D G Q V I
 GGCCCTACCCCTCATCGGAGCCAATGCTCCTCTCTCCATCGCTCTGAATTTCCCTGGCTCCAGAAAGTGCTCCCGATGGCCAAGTGATT

Gene : gp100
 Segment# : 7
 Offset : 91
 1st Codon : 1
 N F P G S Q K V L P D G Q V I W V N N T I I N G S Q V W G G
 AACTTTCCCGAAGCCAAAGGTCTGCTGACGGACAGGTGATCTGGTGAAATAACACAATCATTAAACGAAGCCAAGTGTTGGGGCGGA

Gene : gp100
 Segment# : 8
 Offset : 106
 1st Codon : 1

Figure 27 (Cont)

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W V N N T I I N G S Q V W G G Q P V Y P Q E T D D A C I F P
TGGGTCAACAATACCATATTCAATGGCTCCAGGTCTGGGGAGGCCAACCGTCTACCTCAGGAAACCGATGACGCTTGCAITTTCCCT

Gene : gp100
Segment# : 9
Offset : 121
1st Codon : 1

Q P V Y P Q E T D D A C I F P D G G P C P S G S W S Q K R S
CAGCCTGTGTATCCCCAAGAGACAGACGATGCTGTATCTTTCCCGATGGCGGACCCTGTCCCTCOGGCTCCTGGTCCCAGAAAAGGTCC

Gene : gp100
Segment# : 10
Offset : 136
1st Codon : 1

D G G P C P S G S W S Q K R S F V Y V W K T W G Q Y W Q V L
GACGGAGGCCCTTGCCCTAGCGGAAGCTGGAGCCAAAAGAGAGCTTTGTGTATGTGTGGAAGACATGGGACAGTATTGGCAAGTGCTC

Gene : gp100
Segment# : 11
Offset : 151
1st Codon : 1

P V Y V W K T W G Q Y W Q V L G G P V S G L S I G T G R A M
TTGCTCTACGTCTGGAAACCTGGGGCAATACTGGCAGGTCTGGGAGGCCCTGTGTCTCGGCCTCAGCATGGCACAGGCAGAGCCATG

Gene : gp100
Segment# : 12
Offset : 166
1st Codon : 1

G G P V S G L S I G T G R A M L G T H T M E V T V Y H R R G
GGCGGACCCGTGACGGAGTGTCCATCGGAACCGGAAGGGCTATGCTCGGCACACACAATGGAAGTGACAGTGTATCACAGAAGGGGA

Gene : gp100
Segment# : 13
Offset : 181
1st Codon : 1

L G T H T M E V T V Y H R R G S R S Y V P L A H S S S A P T
CTGGGAACCCATACCATGGAGGTACCGTCTACCATAGGAGAGGTCCAGGTCTACGTCCCCCTCGCCCATAGCTCCAGCGCTTTCA

Gene : gp100
Segment# : 14
Offset : 196
1st Codon : 1

S R S Y V P L A H S S S A P T I T D Q V P P S V S V S Q L R
AGCAGAAGCTATGTGCTCTGGCTCACTCCAGTCCGCCCTTACCAITACCGATCAGGTCCCTTTAGCGTCAGCGTCAGCCAACTGAGA

Gene : gp100
Segment# : 15
Offset : 211
1st Codon : 1

I T D Q V P P S V S V S Q L R A L D G G N K H F L R N Q P L
ATCACAGACCAAGTGCTTTCTCCGTGTCCGTGTCCAGCTCAGGGCTCTGGATGGCGGAAACAAACACTTTCTGAGAAACCAACCCCTC

Gene : gp100
Segment# : 16
Offset : 226
1st Codon : 1

A L D G G N K H F L R N Q P L T F A L Q L H D P S G Y L A E
GCCCTCGAGCGGAGCAATAAGCATTTCTCAGGAATCAGCCTCTGACATTCGCTCTGCAACTGCATGACCCCTAGCGGATACCTCGCCGAA

Gene : gp100
Segment# : 17
Offset : 241
1st Codon : 1

T F A L Q L H D P S G Y L A E A D L S Y T W D F G D S S G T
ACCTTTGCCCTCCAGCTCCAGCATCCCTCCGGCTATCTGGCTGAGGCTGACCTCAGCTATACCTGGGACTTTGGCGATAGCTCGGCACA

Gene : gp100
Segment# : 18
Offset : 256
1st Codon : 1

A D L S Y T W D F G D S S G T L I S R A L V V T H T Y L E P
GCCGATCTGTCTACATGGGATTTCCGAGACTCCAGCGAAACCCCTCATCTCCAGGGCTCTGGTCTGACACACACATACCTCGAGCCT

Figure 27 (Cont)

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Gene : gp100
Segment# : 19
Offset : 271
1st Codon : 1
L I S R A L V V T H T Y L E P G P V T A Q V V L Q A A I P L
CTGATTAGCAGAGCCCTCGTGGTCACCCATACCTATCTGGAAACCCGACCCGTCACCGCTCAGGTGCTGCCAGGCTGCCATTCCCCCTC

Gene : gp100
Segment# : 20
Offset : 286
1st Codon : 1
G P V T A Q V V L Q A A I P L T S C G S S P V P G T T D G H
GGCCCTGTGACAGCCCAAGTGGTCTGCAAGCCGCTATCCCTCTGACAAGCTGTGGCTCCAGCCCTGTGCCCTGGCACAAACCGATGGCCAT

Gene : gp100
Segment# : 21
Offset : 301
1st Codon : 1
T S C G S S P V P G T T D G H R P T A E A P N T T A G Q V P
ACCTCCTGGGAAGCTCCCCCGTCCCGGAACACAGACGGACACAGACCCACAGCCGAAGCCCTAACACAACCGCTGGCCAAGTGCCT

Gene : gp100
Segment# : 22
Offset : 316
1st Codon : 1
R P T A E A P N T T A G Q V P T T E V V G T T P G Q A P T A
AGCCCTACCGCTGAGGCTCCCAATACCAACAGCCGACAGGTCCCAACAACCGAAGTGGTGGGCAAAACCCCTGCCAAGCCCTACCGCT

Gene : gp100
Segment# : 23
Offset : 331
1st Codon : 1
T T E V V G T T P G Q A P T A E P S G T T S V Q V P T T E V
ACCACAGAGGTGCTGGGAACCAACCCGGAACGCTCCACAGCCGAACCCCTCCGGCAAACTCCGTGCAAGTGCTACCAACAGAGTCT

Gene : gp100
Segment# : 24
Offset : 346
1st Codon : 1
E P S G T T S V Q V P T T E V I S T A P V Q M P T A E S T G
GAGCTAGCGGAACCAACGCTCCAGGTCCCAACAACCGAAGTGATTAGCACAGCCCTGTGCAAATGCCTACCGCTGAGTCCACCGGA

Gene : gp100
Segment# : 25
Offset : 361
1st Codon : 1
I S T A P V Q M P T A E S T G M T P R K V P V S E V M G T T
ATTCACACCGCTCCCGTCCAGATGCCACAGCCGAAGCACAGGCATGACCCCTGAGAAAGTGCTGTGTCGAGGTGATGGGAACCA

Gene : gp100
Segment# : 26
Offset : 376
1st Codon : 1
M T P E K V P V S E V M G T T L A E M S T P E A T G M T P A
ATGACACCCGAAAAGTCCCGTCCAGCAAGTGATGGGCACAACCCCTCGCCGAAATGTCCACCCCTGAGGCTACCGGAATGACACCCGCT

Gene : gp100
Segment# : 27
Offset : 391
1st Codon : 1
L A E M S T P E A T G M T P A E V S I V V L S G T T A A Q V
CTGGCTGAGATGAGCACACCCGAAGCCACAGGCATGACCCCTCGCGAAGTGTCATGCTGCTCAGCGGAACCAACAGCCGCTCAGGTC

Gene : gp100
Segment# : 28
Offset : 406
1st Codon : 1
E V S I V V L S G T T A A Q V T T T E W V R T T A R E L P I
GAGTGCAGATTGTGGTCTGTCCGGCACAAACCGCTGCCCAAGTGACAACCAACAGAGTGGGTGGAAACCAACAGCCAGAGAGTCCCCATT

Gene : gp100

Figure 27 (Cont)

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Segment# : 29
Offset : 421
1st Codon : 1
T T T E W V E T T A R E L P I P E P E G P D A S S I M S T E
ACCACAAACGAATGGGTCGAGACAAACCGCTAGCGGAATGCCTATCCCTGAGCCTGAGGGACCCGATGCCTCCAGCATTATGTCCACCGAA

Gene : gp100
Segment# : 30
Offset : 436
1st Codon : 1
P E P E G P D A S S I M S T E S I T G S L G P L L D G T A T
CCGAAACCGAAGGCCCTGACGCTAGCTCCATCATGAGCACAGAGTCCATCAGGCTCCCTGGGACCCCTCCTGGATGGCACAGCCACA

Gene : gp100
Segment# : 31
Offset : 451
1st Codon : 1
S I T G S L G P L L D G T A T L R L V K R Q V P L D C V L Y
AGCATTACCGAAGCCTCGGCCCTCTGCTCGACGGAACCGCTACCCTCAGGCTCGTGAAAAGGCAAGTGCTCTGGATTGGTCTCTGTAT

Gene : gp100
Segment# : 32
Offset : 466
1st Codon : 1
L R L V K R Q V P L D C V L Y R Y G S F S V T L D I V Q G I
CTGAGACTGGTCAAGAGACAGGTCCCCCTCGACTGTGTGCTCTACAGATACGGAAGCTTTAGCGTCACCCCTCGACATTGTGCAAGGCATT

Gene : gp100
Segment# : 33
Offset : 481
1st Codon : 1
R Y G S F S V T L D I V Q G I E S A E I L Q A V P S G E G D
AGGTATGGCTCCTTCTCCGTGACACTGGATATCGTCCAGGGAATCGAAGCGCTGAGATTCTGCAAGCGTCCCTCCGGCGAAGGGCGAT

Gene : gp100
Segment# : 34
Offset : 496
1st Codon : 1
E S A E I L Q A V P S G E G D A F E L T V S C Q G G L P K E
GAGTCGCGGAAATCCTCCAGGCTGTGCTAGCGGAGAGGGAGACGCTTTCGAACTGACAGTGTCTGCAAGGGGAGTGCCTAAGGAA

Gene : gp100
Segment# : 35
Offset : 511
1st Codon : 1
A F E L T V S C Q G G L P K E A C M E I S S P G C Q P P A Q
GCCTTTGAGCTCACCGTCAGCTGTGAGGGAGGCTCCCAAGAGGCTTGCAATGGAGATTAGTCCCCCGGATGCCAACCCCTGCCCAA

Gene : gp100
Segment# : 36
Offset : 526
1st Codon : 1
A C M E I S S P G C Q P P A Q R L C Q P V L P S P A C Q L V
GCCTGTATGGAATCTCCAGCCCTGGCTGTGAGCCTCCCGCTCAGAGACTGTGTGAGCCTGTGCTCCCTCCCGCTTGCCAACCTGGTC

Gene : gp100
Segment# : 37
Offset : 541
1st Codon : 1
R L C Q P V L P S P A C Q L V L H Q I L K G G S G T Y C L N
AGGCTCTGCCAACCCGTCCTGCTAGCCCTGCCTGTGAGCTCGTGTCCACCAAATCCTCAAGGGAGGCTCCGGCACATAGTGTCTGAAT

Gene : gp100
Segment# : 38
Offset : 556
1st Codon : 1
L H Q I L K G G S G T Y C L N V S L A D T N S L A V V S T Q
CTGCATCAGATTCTGAAGGGCGAAGCGGAACCTATTGCCTCAACGTGAGCTCGCGGATACCAATAGCCTCGCGCTGTGTCCACCCAA

Gene : gp100
Segment# : 39
Offset : 571

Figure 27 (Cont)

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1st Codon : 1
V S L A D T N S L A V V S T Q L I M P G Q E A G L G Q V P L
GTGTCCTGGCTGACACAACTCCCTGGCTGTGGTCAGCACACAGCTCATCATGCCCGGACAGGAAGCCGGACTGGGACAGGTCCCCCTC

Gene : gp100
Segment# : 40
Offset : 586
1st Codon : 1
L I M P G Q E A G L G Q V P L I V G I L L V L M A V V L A S
CTGATTATGCTGGCCAAGAGGCTGGCTCGGCCAAGTGCCTCTGATTGTGGGAATCCTCCTGGTCTGATGGCCGTCTGTCTCGCTCC

Gene : gp100
Segment# : 41
Offset : 601
1st Codon : 1
I V G I L L V L M A V V L A S L I Y R R R L M K Q D P S V P
ATCGTCGGCATTCTGTCTGTCTCATGGCTGTGGTCTGGCTAGCTCATCTATAGGAGAAGGCTCATGAAACAGGATTCTCTCGTGCCT

Gene : gp100
Segment# : 42
Offset : 616
1st Codon : 1
L I Y R R R L M K Q D P S V P Q L P H S S S H W L R L P R I
CTGATTACAGAAGGAGACTGATGAAGCAAGACTTTAGCGTCCCCCACTGCCTCACTCCAGCTCCCACTGGCTGAGACTGCCTAGGATT

Gene : gp100
Segment# : 43
Offset : 631
1st Codon : 1
Q L P H S S S H W L R L P R I P C S C P I G E N S P L L S G
CAGCTCCCCATAGCTCCAGCCATTGGCTCAGGCTCCCCAGAATCTTTGCTCCTCGCCTATCGGAGAGAATAGCCCTCTGTCTCAGCGGA

Gene : gp100
Segment# : 44
Offset : 646
1st Codon : 1
P C S C P I G E N S P L L S G Q Q V A A
TTCGTAGCTGTCCCATGGCGAAACTCCCCCTCCTGTCCGGCCAAAGGTGCGCGT

Gene : MART
Segment# : 1
Offset : 1
1st Codon : 1
A A M P R E D A H F I Y G Y P K K G H G H S Y T T A E E A A
GCGCTATGCTAGGGAAGACGCTCACTTTATCTATGGCTATCCCAAAAGGGACAGGACACTCTACACAAACCGCTGAGGAAGCCGCT

Gene : MART
Segment# : 2
Offset : 16
1st Codon : 1
K K G H G H S Y T T A E E A A G I G I L T V I L G V L L L I
AAGAAAGCCATGGCCATAGCTATACACAGCCGAAGAGGCTGCGGAAATCGGAATCCTCACCGTCATCCTCGGCGTCTGTCTCTGATT

Gene : MART
Segment# : 3
Offset : 31
1st Codon : 1
G I G I L T V I L G V L L L I G C W Y C R R R R N G Y R A L M
GCCATTGGCATTCTGACAGTGATTCTGGGAGTGCTCCTGCTCATCGGATGCTGGTACTGTAGGAGAAGGAATGCCCTATAGGGCTCTGATG

Gene : MART
Segment# : 4
Offset : 46
1st Codon : 1
G C W Y C R R R R N G Y R A L M D K S L H V G T Q C A L T R R
GGCTGTTGGTATTGCAGAAGGAGAAACGATACAGAGCCCTCATGGATAAGTCCCTGCATGTGGGAACCAATGCGCTCTGACAAGGAGA

Gene : MART
Segment# : 5
Offset : 61
1st Codon : 1
D K S L H V G T Q C A L T R R C P Q E G F D H R D S K V S L

Figure 27 (Cont)

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GACAAAAGCCTCCACGTCCGGCACACAGTGTGCCCTCACCAGAAGGTGTCCCCAAGAGGGATTGGATCACAGAGACTCCAAGGTCAGCCTC

Gene : MART

Segment# : 6

Offset : 76

1st Codon : 1

C P Q E G F D H R D S K V S L Q E K N C E P V V P N A P P A
TGCCCTCAGGAAGCCTTTGACCATAGGGATAGCAAAGTGTCCCTGCAAGAGAAAACTGTGAGCCTGTGGTCCCCAATGCCCCCTCCCGCT

Gene : MART

Segment# : 7

Offset : 91

1st Codon : 1

Q E K N C E P V V P N A P P A Y E K L S A E Q S P F P Y S P
CAGGAAAAGAAATGCGAACCGTGGCTAACGCTCCCCCTGCCTATGAGAACTGTGCGCGAACAGTCCCCCCCCCTCCCTATAGCCCT

Gene : MART

Segment# : 8

Offset : 106

1st Codon : 1

Y E K L S A E Q S P P P Y S P A A
TAGGAAAAGCTCAGCGCTGAGCAAAGCCCTCCCCCTTACTCCCCCGCTGCC

Gene : TRP-1

Segment# : 1

Offset : 1

1st Codon : 1

A A P A F L T W H R Y H L L R L E K D M Q E M L Q E P S F S
CGCGTCCCGCTTTCTCTCACCCTGGCACAGATACCATCTGCTCAGGCTCGAGAAAGACATGCAGGAAATGCTCCAGGAACCCCTCCTTCTCC

Gene : TRP-1

Segment# : 2

Offset : 16

1st Codon : 1

L E K D M Q E M L Q E P S F S L P Y W N F A T G K N V C D I
CTGGAAAAGGATATGCAAGAGATGCTGCAAGAGCCTAGCTTTAGCCTCCCCCTATTGGAATTTGCTACCGGAAAAGAAATGTGTGTGACATT

Gene : TRP-1

Segment# : 3

Offset : 31

1st Codon : 1

L P Y W N F A T G K N V C D I C T D D L M G S R S N F D S T
CTGCCTTACTCGAACTTTGCCACAGGCAGCAAAACGCTCGGATATCTGTACCGATGACCTCATGGGAAGCAGAACCAATTTGATAGCACAA

Gene : TRP-1

Segment# : 4

Offset : 46

1st Codon : 1

C T D D L M G S R S N F D S T L I S P N S V F S Q W R V V C
TGACAGACGATCTGATGGGCTCCAGGTCCAACCTTGACTCCACCCCTCATCTCCCCCAATAGCGTCTTCTCCAGTGGAGGGTGTGTGT

Gene : TRP-1

Segment# : 5

Offset : 61

1st Codon : 1

L I S P N S V F S Q W R V V C D S L E D Y D T L G T L C N S
CTGATTAGCCCTAACTCCGTGTTTAGCCAATGGAGAGTGGTCTGCGATAGCCTCGAGGATTACGATACCCCTGGCACACTGTGTAACTCC

Gene : TRP-1

Segment# : 6

Offset : 76

1st Codon : 1

D S L E D Y D T L G T L C N S T E D G P I R R N P A G N V A
GACTCCCTGGAGACTATGACAACTGGGAACCCCTCTGCAATAGCACAGAGGATGGCCCTATCAGAAGGAATCCCGCTGGCAATGTGGCT

Gene : TRP-1

Segment# : 7

Offset : 91

1st Codon : 1

T E D G P I R R N P A G N V A R P M V Q R L P E P Q D V A Q
ACCGAAGACGGACCCATTAGGAGAAACCTTGGCGAAACGTCGCCAGACCCATGGTGCAAGGCTCCCCGAACCCCAAGAGCTGCCCA

Figure 27 (Cont)

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Gene : TRP-1

Segment# : 8

Offset : 106

1st Codon : 1

R P M V Q R L P E P Q D V A Q C L E V G L F D T P P F Y S N
AGGCCTATGGTCCAGAGACTGCCTGAGCCTCAGGATGTGGCTCAGTGTCTGGAAGTGGGACTGTTTGACACACCCCTTTCTATAGCAAT

Gene : TRP-1

Segment# : 9

Offset : 121

1st Codon : 1

C L E V G L F D T P P F Y S N S T N S P R N T V E G Y S D P
TGCTCGAGGTGGCCTCTTGATACCCCTCCCTTTTACTCCAACTCCACCAATAGCTTTAGGAATACCGTCGAGGGATACTCCGACCCCT

Gene : TRP-1

Segment# : 10

Offset : 136

1st Codon : 1

S T N S P R N T V E G Y S D P T G K Y D P A V R S L H N L A
AGCACAACTCCTTCAGAAACACAGTGAAGGCTATAGCGATCCACAGGCAATACGATCCCGCTGTGAGAAGCCTCCCAATCTGGCT

Gene : TRP-1

Segment# : 11

Offset : 151

1st Codon : 1

T G K Y D P A V R S L H N L A H L P L N G T G G Q T H L S S
ACCGGAAAGTATGACCTGCGTCAGGTCCCTGCATAACCTCGCCCATCTGTTTCTGAATGGCACAGGCGGACAGACACACCTCAGCTCC

Gene : TRP-1

Segment# : 12

Offset : 166

1st Codon : 1

H L F L N G T G G Q T H L S S Q D P I F V L L H T F T D A V
CACCTCTTCTCAACGGAACCGGAGGCCAAACCCATCTGTCCAGCCAAGACCCCTATCTTTGTGCTCCTGCATACCTTTACCGATGCGGTC

Gene : TRP-1

Segment# : 13

Offset : 181

1st Codon : 1

Q D P I F V L L H T F T D A V P D E W L R R Y N A D I S T F
CAGGATCCCAATTTCTGCTCTGCCACATTACAGACGCTGTGTTTGACGAATGGCTCAGGAGATACAATGCCGATATCTCCACCTTT

Gene : TRP-1

Segment# : 14

Offset : 196

1st Codon : 1

P D E W L R R Y N A D I S T F P L E N A P I G H N R Q Y N M
TTGATGAGTGGCTGAGAAGGTATAACGCTGACATTAGCACATTCCTCTCTGAAAAGCTCCCATTTGGCCATAACAGACAGTATAACATG

Gene : TRP-1

Segment# : 15

Offset : 211

1st Codon : 1

P L E N A P I G H N R Q Y N M V P P W P P V T N T E M F V T
CCCGTCGAGAATGCCCTATCGGACACAATAGGCAATACAATATGGTCCTCTTTGGCCTCCCGTCACCAATACCGAAATGTTTGTGACA

Gene : TRP-1

Segment# : 16

Offset : 226

1st Codon : 1

V P P W P P V T N T E M F V T A P D N L G Y T Y E A A
GTGCCTTTCTGGCCCCCTGTGACAAACACAGAGATGTTGCTCACCGCTCCCGATAACCTCGGCTATACCTATGAGGCTGCC

Gene : Tyros

Segment# : 1

Offset : 1

1st Codon : 1

A A M L L A V L Y C L L W S F Q T S A G H F P R A C V S S K
CGCGTATGCTCTGGCTGTGCTCTACTGTCTGCTCTGGTCCCTCCAAACCTCCGCGGACACTTTCCAGAGCCTGTGTGTCCAGCAAA

Gene : Tyros

Segment# : 2

Figure 27 (Cont)

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Offset : 16
1st Codon : 1
Q T S A G H F P R A C V S S K N L M E K E C C P P W S G D R
CAGACAAGCGCTGGCCATTTCCCTAGGGCTTGGCTCAGCTCCAAGAATCTGATGGAGAAAGAGTGTTCCTCCCTGGAGCGGAGACAGA

Gene : Tyros
Segment# : 3
Offset : 31
1st Codon : 1
N L M E K E C C P P W S G D R S P C G Q L S G R G S C Q N I
AACCTCATGGAAAGGAATGCTGTCCCCCTTGGTCGGGCGATAGGTCCCCCTGTGGCCAACTGTCCGCGAGAGGCTCCTGCCAAAACATT

Gene : Tyros
Segment# : 4
Offset : 46
1st Codon : 1
S P C G Q L S G R G S C Q N I L L S N A P L G P Q F P P T G
AGCCCTTGGCGACGCTCAGCGGAAGGGGAAGCTGTGAGAAATATCTCTGTCCAAAGCTCCCTCGGCCC TCAGTTCCCTTTACCGGA

Gene : Tyros
Segment# : 5
Offset : 61
1st Codon : 1
L L S N A P L G P Q F P P T G V D D R E S W P S V F Y N R T
CTGCTCAGCAATGCCCTCTGGGACCCCAATTCCTTTTACAGGGCTCGACGATAGGGAAAGCTGGCCCTCCGTGTTTTACAATAGGACA

Gene : Tyros
Segment# : 6
Offset : 76
1st Codon : 1
V D D R E S W P S V F Y N R T C Q C S G N F M G F N C G N C
GTGGATGACAGAGAGTCTGGCCCTAGCGTCTTCTATAACAGAACTGTCTAGTGTAGCGGAAACTTTATGGGATTCAATTGCGGAAACTGT

Gene : Tyros
Segment# : 7
Offset : 91
1st Codon : 1
C Q C S G N F M G F N C G N C K F G F W G P N C T E R R L L
TGCCATGCTCGGCAATTTTCATGGGCTTTAACTGTGGCAATTGCAAAATTCGGATTCTGGGGCCCTAACTGTACCGAAAGGAGACTGCTC

Gene : Tyros
Segment# : 8
Offset : 106
1st Codon : 1
K F G F W G P N C T E R R L L V R R N I F D L S A P E K D K
AAGTTGGCTTTTGGGACCCCAATTGCACAGAGAGAGGCTCCTGGTCAGGAGAAACATTTTGGATCTGTCGCCCCCTGAGAAAGACAAA

Gene : Tyros
Segment# : 9
Offset : 121
1st Codon : 1
V R R N I F D L S A P E K D K F F A Y L T L A K H T I S S D
GTGAGAAGGAATATCTTTGACCTCAGCGCTCCCCGAAAAGGATAAGTTTTCGCTTACCTCACCCCTCGCCAAACACACAATCTCCAGCGAT

Gene : Tyros
Segment# : 10
Offset : 136
1st Codon : 1
F F A Y L T L A K H T I S S D Y V I P I G T Y G Q M K N G S
TTCTTTGCTATCTGACACTGGCTAAGCATACCAATTAGCTCGACTATGTGATTCCTTGGCACATACGGACAGATGAAGAATGGCTCC

Gene : Tyros
Segment# : 11
Offset : 151
1st Codon : 1
Y V I P I G T Y G Q M K N G S T P M F N D I N I Y D L F V W
TAGTCATCCCTATCGGAACCTATGGCCAAATGAAAAAGGAGACACCCATGTTCAATGACATTAACTTTACGATCTGTTTGTGTGG

Gene : Tyros
Segment# : 12
Offset : 166
1st Codon : 1

Figure 27 (Cont)

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T P M F N D I N I Y D L F V N M H Y Y V S M D A L L G G S E
ACCCCTATGTTTAAACGATATCAATATCTATGACCTCTTCGCTCGGATGCACTATTACGTCAGCATGGACGCTCTGCTCGGCGGAAGCGAA

Gene : Tyros
Segment# : 13
Offset : 181
1st Codon : 1

M H Y Y V S M D A L L G G S E I W R D I D F A H E A P A P L
ATGCATTACTATGTGTCATGGATGCCCTCCTGGGAGGCTCCGAGATTGGAGAGACATTGACTTTGCCCATGAGGCTCCCGCTTCTCTC

Gene : Tyros
Segment# : 14
Offset : 196
1st Codon : 1

I W R D I D F A H E A P A P L P W H R L F L L R W E Q E I Q
ATCTGGAGGGATATCGATTTCGCTCACGAAGCCCTGCCTTTCTGCCTGGCATAGGCTCTTCTCCTGAGATGGGAACAGGAAATCCAA

Gene : Tyros
Segment# : 15
Offset : 211
1st Codon : 1

P W H R L F L L R W E Q E I Q K L T G D E N F T I P Y W D W
CCCTGGCACAGACTGTTCTGCTCAGGTGGGAGCAAGAGATTGAGAACTGACAGGCGATGAGAATTCACAAATCCCTTACTGGGACTGG

Gene : Tyros
Segment# : 16
Offset : 226
1st Codon : 1

K L T G D E N F T I P Y W D W R D A E K C D I C T D E Y M G
AAGCTCACCGGAGACGAAAACCTTACCATTCCTATTGGGATTGGAGAGACGCTGAGAAATGCGATATCTGTACCGATGAGTATATGGGA

Gene : Tyros
Segment# : 17
Offset : 241
1st Codon : 1

R D A E K C D I C T D E Y M G G Q H P T N P N L L S P A S F
AGGGATGCCGAAAAGTGTGACATTTCACAGACGAATACATGGGCGGACAGCATCCACAAACCTTAACCTCCTGTCTCCCGCTAGCTTT

Gene : Tyros
Segment# : 18
Offset : 256
1st Codon : 1

G Q H P T N P N L L S P A S F F S S W Q I V C S R L E E Y N
GGCCAAACACCTACCAATCCCAATCTGCTCAGCCCTGCCTCCTTCTTAGCTCCTGGCAAATCGTCTGCTCCAGGCTGAGGAATACAAT

Gene : Tyros
Segment# : 19
Offset : 271
1st Codon : 1

F S S W Q I V C S R L E E Y N S H Q S L C N G T P E G P L R
TTCTCCAGCTGGCAGATTGTGTGTAGCAGACTGGAAGAGTATACTCCCAACCAAGCCTCTGCAATGGCACACCCGAAGGCCCTCTGAGA

Gene : Tyros
Segment# : 20
Offset : 286
1st Codon : 1

S H Q S L C N G T P E G P L R R N P G N H D K S R T P R L P
AGCCATCAGTCCCTGTGTAAAGGAACCCCTGAGGGACCCCTCAGGAGAAACCTGGCAATCAGGATAAGTCCAGGACACCCAGACTGCCT

Gene : Tyros
Segment# : 21
Offset : 301
1st Codon : 1

R N P G N H D K S R T P R L P S S A D V E F C L S L T Q Y E
AGGAATCCCGAAACCATGACAAAGCAGAACCCCTAGGCTCCCTCCAGCGCTGACGTCGAGTTTTCCTCAGCCTCACCAATACGAA

Gene : Tyros
Segment# : 22
Offset : 316
1st Codon : 1

S S A D V E F C L S L T Q Y E S G S M D K A A N P S F R N T
AGCTCCGCGATGTGGAATTCGTCTGTCTCCTGACACAGTATGAGTCGGCTCCATGGATAAGGCTGCCAATTTCTCCTTCAGAAACACA

Figure 27 (Cont)

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Gene : Tyros
Segment# : 23
Offset : 331
1st Codon : 1
S G S M D K A A N P S F R N T L E G F A S P L T G I A D A S
ACGGGAAGCATGGACAAAGCGCTAACTTTAGCTTTAGGAATACCTCGAGGGATTGCTAGCCCTCTGACAGGCATTGCCGATGGCTCC

Gene : Tyros
Segment# : 24
Offset : 346
1st Codon : 1
L E G F A S P L T G I A D A S Q S S M H N A L H I Y M N G T
CTGGAAGGCTTTGCCCTCCCCCTCACGGGAATCGCTGACGCTAGCCAAAGCTCCATGCATAAGCTCTGCATATCTATATGAATGGCACA

Gene : Tyros
Segment# : 25
Offset : 361
1st Codon : 1
Q S S M H N A L H I Y M N G T M S Q V Q G S A N D P I F L L
CAGTCCAGCATGCACATGCCCTCCACATTTACATGAACGGAAACCATGAGCCAGTGCAAGGCTCCGCCAATGACCTATCTTTCTGCTC

Gene : Tyros
Segment# : 26
Offset : 376
1st Codon : 1
M S Q V Q G S A N D P I F L L H H A F V D S I F E Q W L Q R
ATGTCCAGGTCCAGGAAGCGCTAACGATCCCATTTTCCTCCTGCATCAGCTTTGCTGACTCCATCTTTGAGCAATGGCTCCAGAGA

Gene : Tyros
Segment# : 27
Offset : 391
1st Codon : 1
H H A F V D S I F E Q W L Q R H R P L Q E V Y P E A N A P I
CACCATGCCTTTGTGGATAGCATTTTCGAACAGTGGCTGCAAAGGCATAGCCCTCTGCAAGAGGTCTACCTGAGGCTAACGCTCCCAT

Gene : Tyros
Segment# : 28
Offset : 406
1st Codon : 1
H R P L Q E V Y P E A N A P I G H N R E S Y M V P P I P L Y
CACAGACCCCTCCAGGAAGTGATCCCGAAGCCAATGCCCTATCGGACACAATAGGGAAGCTATATGGTCCCTTTATCCCTCTGTAT

Gene : Tyros
Segment# : 29
Offset : 421
1st Codon : 1
G H N R E S Y M V P P I P L Y R N G D F F I S S K D L G Y D
GGCCATAACAGAGAGTCTACATGGTGCCCTTTCATTCCCTCTACAGAAAGGAGACTTTTTCATTAGCTCCAAGGATCTGGGATACGAT

Gene : Tyros
Segment# : 30
Offset : 436
1st Codon : 1
R N G D F F I S S K D L G Y D Y S Y L Q D S D P D S F Q D Y
AGGAATGGCGATTTCTTTATCTCCAGCAAAGACCTCGGCTATGACTATAGCTATCTGCAAGACTCCGACCCCTGACTCCTTCCAGACTAT

Gene : Tyros
Segment# : 31
Offset : 451
1st Codon : 1
Y S Y L Q D S D P D S F Q D Y I K S Y L E Q A S R I W S W L
TACTCTACCTCCAGGATAGCGATCCCGATAGCTTTCAGGATTACATTAAGTCTACCTGAGCAAGCCTCCAGGATTGGTCTGGCTC

Gene : Tyros
Segment# : 32
Offset : 466
1st Codon : 1
I K S Y L E Q A S R I W S W L L G A A M V G A V L T A L L A
ATCAAAGCATCTGGAACAGGCTAGCAGAACTCGGAGCTGGCTGCTCGGCGCTGCCATGGTGGGAGCGTCTGACAGCCCTCTGGCT

Gene : Tyros

Figure 27 (Cont)

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Segment# : 33
Offset : 481
1st Codon : 1
L G A A M V G A V L T A L L A L V S L L C R H K R K Q L P
CTGGGAGCCGCTATGGTCGGCGCTGTGCTCACCGCTCTGCTCGCCGACTGGTCAGCCTCCTGTGTAGGCATAAGAGAAAAGCAACTGCCT

Gene : Tyros
Segment# : 34
Offset : 496
1st Codon : 1
G L V S L L C R H K R K Q L P E E K Q P L L M E K E D Y H S
GGCCTCGTGTCCCTGCTCTGCAGACACAAAAGGAAACAGCTCCCGAAGAGAAACAGCCTCTGCTCATGGAAAAGGAAGACTATCACTCC

Gene : Tyros
Segment# : 35
Offset : 511
1st Codon : 1
E E K Q P L L M E K E D Y H S L Y Q S H L A A
GAGGAAAAGCAACCCCTCCTGATGGAGAAAGAGGATTACCATAGCCTCTACCAAAGCCATCTGGCTGCC

Gene : TRP2
Segment# : 1
Offset : 1
1st Codon : 1
A A M S P L W W G F L L S C L G C K I L P G A Q G Q P P R V
GCGCTATGTCCCCCTCTGGTGGGGCTTCTGCTCAGCTGTCTGGGATGCAAAATCCTCCCGGAGCCCAAGGCCAATTCCCTAGGGTC

Gene : TRP2
Segment# : 2
Offset : 16
1st Codon : 1
G C K I L P G A Q G Q P P R V C M T V D S L V N K E C C P R
GGCTGTAAGATTCTGCCTGGCGCTCAGGGACAGTTTCCAGAGTGTGTATGACAGTGGATAGCCTCGTGAATANGGAATGCTGTCCCA

Gene : TRP2
Segment# : 3
Offset : 31
1st Codon : 1
C M T V D S L V N K E C C P R L G A E S A N V C G S Q Q G R
TGCATGACCGTGCAGTCCCTGGTCAACAAAGAGTGTGCGCTAGGCTCGGCGCTGAGTCCGCCAATGTGTGTGGCTCCAGCAAGGCAGA

Gene : TRP2
Segment# : 4
Offset : 46
1st Codon : 1
L G A E S A N V C G S Q Q G R G Q C T E V R A D T R P N S G
CTGGAGCCGAAAGCGCTAACGTCTCGGGAAGCCAACAGGGAAGGGGACAGTGTACCGAAGTGAGAGCCGATACCAGACCTTGGAGCGGA

Gene : TRP2
Segment# : 5
Offset : 61
1st Codon : 1
G Q C T E V R A D T R P N S G P Y I L R N Q D D R E L W P R
GGCCAATGCACAGAGTTCAGGGCTGACACAAAGCCTTGGTCCGGCCCTTACATTCTGAGAAACCAAGACGATAGGGAAGTGTGGCCCA

Gene : TRP2
Segment# : 6
Offset : 76
1st Codon : 1
P Y I L R N Q D D R E L W P R K P F P H R T C K C T G N F A G
CCCTATATCCTCAGGAATCAGGATGACAGAGAGCTCTGGCCTAGGAAATCTTTACAGAACTGTAAAGTGTACCGGAACTTTGCCGGA

Gene : TRP2
Segment# : 7
Offset : 91
1st Codon : 1
K P F H R T C K C T G N F A G Y N C G D C K F G W T G P N C
AAGTTTTTCCATAGGACATGCAAAATGCACAGGCAATTTGCTGGCTATACTGTGGGATGCAAAATTCGGATGGACAGGCCCTAACTGT

Gene : TRP2
Segment# : 8
Offset : 106

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1st Codon : 1
Y N C G D C K P G W T G P N C E R K K P P V I R Q N I H S L
TACAATTGGCGAGACTGTAAGTTTGGCTGGACCGGACCCCAATTGCGAAAGGAAAAAGCCTCCCGTCATCAGACAGAATATCCATAGCCTC

Gene : TRP2
Segment# : 9
Offset : 121
1st Codon : 1
E R K K P P V I R Q N I H S L S P Q E R E Q F L G A L D L A
GAGAGAAAGAAACCCCTGTGATTAGGCAAAACATTCACTCCCTGTGCCCCCAAGAGAGAGCAATTCTCTGGCGCTCTGGATCTGGCT

Gene : TRP2
Segment# : 10
Offset : 136
1st Codon : 1
S P Q E R E Q F L G A L D L A K K R V H P D Y V I T T Q H W
AGCCCTCAGGAAAGGAACAGTTTCTGGGAGCCCTCGACCTCGCCAAAAGAGAGTGATCCCGATTACGTATCACAACCCAACTG

Gene : TRP2
Segment# : 11
Offset : 151
1st Codon : 1
K K R V H P D Y V I T T Q H W L G L L G P N G T Q P Q F A N
AAGAAAGGGTCCACCCTGACTATGTGATTACACACAGCATTGGCTGGGCTCCTGGGACCCAAATGGCACACAGCCTCAGTTTGCCAAT

Gene : TRP2
Segment# : 12
Offset : 166
1st Codon : 1
L G L L G P N G T Q P Q F A N C S V Y D F P V W L H Y Y S V
CTGGGACTGCTGGGCCCTAAACGGAACCCAAACCCCAATTGCTAACTGTAGCGTCTACGATTCTTTGTGTGGCTGCATTACTATAGCGTC

Gene : TRP2
Segment# : 13
Offset : 181
1st Codon : 1
C S V Y D F P V W L H Y Y S V R D T L L G P G R P Y R A I D
TGCTCGGTGTATGACTTTTCTGTGGCTCCACTATTACTCCGTGAGAGACACACTGCTCGGCCCTGGCAGACCCCTATAGGGCTATCGAT

Gene : TRP2
Segment# : 14
Offset : 196
1st Codon : 1
R D T L L G P G R P Y R A I D F S H Q G P A P V T W H R Y H
AGGATACCCCTCTGGGACCCGGAAGGCCTTACAGAGCCATTGACTTTAGCCATCAGGGACCCGCTTTCGTACCTGGCACAGATACCAT

Gene : TRP2
Segment# : 15
Offset : 211
1st Codon : 1
P S H Q G P A P V T W H R Y H L L C L E R D L Q R L I G N E
TTCTCCCAAGGCCCTGCCTTTGTGACATGGCATAGGTATCACTCCTGTGTCTGGAAAGGGATCTGCAAAGGCTCATCGGAAACGAA

Gene : TRP2
Segment# : 16
Offset : 226
1st Codon : 1
L L C L E R D L Q R L I G N E S F A L P P A T G R N E
CTGCTCTGCTCGAGAGAGACCTCCAGAGACTGATTGGCAATGAGTCTCTGCTCTGCTTACTGGAACTTTGCCACAGGCAGAAACGAA

Gene : TRP2
Segment# : 17
Offset : 241
1st Codon : 1
S F A L P Y W N F A T G R N E C D V C T D Q L P G A A R P D
AGCTTTGCCCTCCCTATTGGAATTTGCGTACCGGAAGGAATGAGTGTGACGTCTGCACAGACCAACTGTTTGGCGCTGCCAGACCCGAT

Gene : TRP2
Segment# : 18
Offset : 256
1st Codon : 1
C D V C T D Q L P G A A R P D D P T L I S R N S R F S S W E

Figure 27 (Cont)

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TGC GAT GTG TGT ACC GAT CAG CTCT TCG GAG CGC TAG GCG CTG ACG ATCC CAC TGA TTAG CAG AAA CTCC AGG TTT AG CTCT CCG GAA

Gene : TRP2

Segment# : 19

Offset : 271

1st Codon : 1

D P T L I S R N S R F S S W E T V C D S L D D Y N H L V T L
GAC CTA CCT CAT CTC CAG GAATAG CAG ATTCT CCA GCTGG GAG ACG TGTGT GACTCC CTGG ATG ACTATA ACC ATCTGG TCA CCG CT

Gene : TRP2

Segment# : 20

Offset : 286

1st Codon : 1

T V C D S L D D Y N H L V T L C N G T Y E G L L R R N Q M G
ACCG TCTGCG ATAGCCTCG ACG ATTACA ATCAC CTG TGAC ACTG GTAAC GGAACCTATG AGG GACTGCTC AGGAG AAAACCAA TGGGA

Gene : TRP2

Segment# : 21

Offset : 301

1st Codon : 1

C N G T Y E G L L R R N Q M G R N S M K L P T L K D I R D C
TGCA ATGG CACATA CGAAGG CCTCTCTG AGAAGGA ATCAG ATGGG CAGAAA CTCCATG AAACTG CCTAC CCTCAAG GATATCAG AGACTGT

Gene : TRP2

Segment# : 22

Offset : 316

1st Codon : 1

R N S M K L P T L K D I R D C L S L Q K F D N P P P F Q N S
AGGA ATAG CATGA AGCTCC CCAC ACTGAA AGACATTAG GGA TTG CCTCAG CCTCC AGAAATTCG ATAAC CCTCC CTTTTC CAAA ACTCC

Gene : TRP2

Segment# : 23

Offset : 331

1st Codon : 1

L S L Q K F D N P P P F Q N S T F S P R N A L E G F D K A D
CTGTCC CTGCAAA AGTTTG ACAATCC CCGCTTCTTT CAGA ATAGC ACATTCT CTTCA GAAACG CTCTG GAAGG CTTTG ACAAA GCGGAT

Gene : TRP2

Segment# : 24

Offset : 346

1st Codon : 1

T F S P R N A L E G F D K A D G T L D S Q V M S L H N L V H
ACCTTTAG CTTTAG GAATGCC CCGCTCG AGGGATTG CATAAG GGTGAC GGAACCTCG ACTCC CAGGTCATGT CCGCTGC ATAACCTCG TGCAT

Gene : TRP2

Segment# : 25

Offset : 361

1st Codon : 1

G T L D S Q V M S L H N L V H S F L N G T N A L P H S A A N
GGCACA CTGG ATAGCCA AGTGATG AGCCTCC ACAATCTGG TCCACTCCTT CCTCA ACGGAACCAATG CCGCTC CCGCATAG CGCTGCCAAT

Gene : TRP2

Segment# : 26

Offset : 376

1st Codon : 1

S F L N G T N A L P H S A A N D P I P V V L H S F T D A I P
AGCTTTCTGA ATGG CACAAA CGCTCTG CCTCACTCC GCGGCTAAC GATCCCATTT TCGTCTGTGCTCC ACTCCTT CACAGACGCTATCTTT

Gene : TRP2

Segment# : 27

Offset : 391

1st Codon : 1

D P I P V V L H S F T D A I P D E W M K R F N P P A D A W P
GACCTATCTTTTGTGGTCTCTGCATAGCTTTACCGATGCCATTTTCGATGAGTGGATGAAAAGGTTTAAACCTCCCGCTGACGCTTGCCCT

Gene : TRP2

Segment# : 28

Offset : 406

1st Codon : 1

D E W M K R F N P P A D A W P Q E L A P I G H N R M Y N M V
GACGAATGGATGAAGAGATTCAATCCCCCTGCGGATGCTGGCCCCAAGAGCTCGCCCCCTATCGGACACAATAGGATGTACAATATGGTC

Figure 27 (Cont)

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Gene : TRP2
Segment# : 29
Offset : 421
1st Codon : 1
Q E L A P I G H N R M Y N M V P F F P P V T N E E L F L T S
CAGGAACTGGCTCCCATGGCCATAACAGAATGTATAACATGGTGCCCTTTCTTTCCCCCTGTGACAAACGAAGAGCTCTTCCTCACCTCC

Gene : TRP2
Segment# : 30
Offset : 436
1st Codon : 1
P F P P P V T N E E L F L T S D Q L G Y S Y A I D L P V S V
CCCTTTTTCCTCCCGTCACCAATGAGGAACTGTTCTGACAAGCGATCAGCTCGGCTATAGCTATGCCATTGACCTCCCGTCAGCGTC

Gene : TRP2
Segment# : 31
Offset : 451
1st Codon : 1
D Q L G Y S Y A I D L P V S V E E T P G W P T T L L V V M G
GACCAACTGGGATACTCTACGCTATCGATCTGCTGTGTCGGTGGAGAGACACCCGGATGGCCTACCACACTGCTCGTGGTCATGGGA

Gene : TRP2
Segment# : 32
Offset : 466
1st Codon : 1
E E T P G W P T T L L V V M G T L V A L V G L F V L L A F L
GAGGAAACCCCTGGCTGGCCCAACCCCTCCTGGTGTGATGGGCACACTGGTCCGCTTGGGGACTGTTTGTGCTCTGGCTTTCTCT

Gene : TRP2
Segment# : 33
Offset : 481
1st Codon : 1
T L V A L V G L F V L L A F L Q Y R R L R K G Y T P L M E T
ACCTCTGGCTCTGGTCCGCTCTCTGTCCTGCTGCGCTTTCTGCAATACAGAAGGCTCAGGAAAGGCTATACCCCTCTGATGGAGACA

Gene : TRP2
Segment# : 34
Offset : 496
1st Codon : 1
Q Y R R L R K G Y T P L M E T H L S S K R Y T E E A A A
CAGTATAGGAGACTGAGAAAGGATACACACCCCTCATGGAACCCATCTGTCCAGCAAAAGGTATACCGAAGAGGCTGCCGCT

Gene : MC1R
Segment# : 1
Offset : 1
1st Codon : 1
A A M A V Q G S Q R R L L G S L N S T P T A I P Q L G L A A
GCCGCTATGGCTGTGCAAGGCTCCAGAGAGGCTCCTGGGAAGGCTCAACTCCACCCCTACCGCTATCCCTCAGCTGGGCTCGCGCT

Gene : MC1R
Segment# : 2
Offset : 16
1st Codon : 1
L N S T P T A I P Q L G L A A N Q T G A R C L E V S I S D G
CTGAATAGCACACCCACAGCCATTCCCCAACTGGGACTGGCTGCCAATCAGACAGGCGTAGGTGTCTGGAAGTGTCCATCTCCGACCGA

Gene : MC1R
Segment# : 3
Offset : 31
1st Codon : 1
N Q T G A R C L E V S I S D G L F L S L G L V S L V E N A L
AACCAACCGGAGCCAGATGCTCGAGGTGAGCATTAGCGATGGGCTCTTCTCAGCCTGGGCTGTGTCCCTGGTGGAGATGCCCTC

Gene : MC1R
Segment# : 4
Offset : 46
1st Codon : 1
L F L S L G L V S L V E N A L V V A T I A K N R N L H S P M
CTGTTTCTGTCCCTGGGACTGGTCAGCCTCGTGAAACGCTCTGGTGTGGCTACCATTGCCAAAACAGAAACCTCCACTCCCCCTC

Gene : MC1R
Segment# : 5

Figure 27 (Cont)

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Offset : 61
1st Codon : 1
V V A T I A K N R N L H S P M Y C F I C C L A L S D L L V S
GTGGTCGCCACAATCGCTAAGAATAGGAATCTGCATAGCCCTATGTATTGCTTTATCTGTTGCCCTGCCCTCAGCGATCTGCTCGTGTCC

Gene : MC1R
Segment# : 6
Offset : 76
1st Codon : 1
Y C F I C C L A L S D L L V S G T N V L E T A V I L L L E A
TACTGTTTCATTGTGCTGTGGCTCTGTCCGACCTCCTGGTCAGCGGAACCAATGTGCTCGAGACAGCCGTCATCCTCCTGCTCGAGGCT

Gene : MC1R
Segment# : 7
Offset : 91
1st Codon : 1
G T N V L E T A V I L L L E A G A L V A R A A V L Q Q L D N
GGCACAAGCTCCTGGAACCGCTGTGATTCTGCTCCTGGAAGCCGGAGCCCTCGTGGCTAGGGCTGCCGTCCTGCAACAGCTCGACAAT

Gene : MC1R
Segment# : 8
Offset : 106
1st Codon : 1
G A L V A R A A V L Q Q L D N V I D V I T C S S M L S S L C
GGCGCTCTGGTCGCCAGAGCCGCTGTGCTCCAGCAACTGGATAACGTCATCGATGTGATTACCTGTAGCTCCATGCTCAGCTCCCTGTGT

Gene : MC1R
Segment# : 9
Offset : 121
1st Codon : 1
V I D V I T C S S M L S S L C F L G A I A V D R Y I S I F Y
GTGATTGACGTATCAGATGCTCCAGCATGCTGTCCAGCCTCTGCTTTCTGGGAGCCATTGCCGTCGACAGATACATTAGCATTTTCTAT

Gene : MC1R
Segment# : 10
Offset : 136
1st Codon : 1
F L G A I A V D R Y I S I F Y A L R Y H S I V T L P R A P R
TTCTGGCGCTATCGCTGTGGATAGGTATATCTCCATCTTTTACGCTCTGAGATACCATAGCATTTGTGACACTGCCTAGGGCTCCCGA

Gene : MC1R
Segment# : 11
Offset : 151
1st Codon : 1
A L R Y H S I V T L P R A P R A V A A I W V A S V V F S T L
GCCCTCAGGTATCACTCCATCGTCACCCCTCCCGAGAGCCCTAGGGCTGTGGCTGCCATTGGGTCGCCCTCCGTGGTCTTCTCCACCCCTC

Gene : MC1R
Segment# : 12
Offset : 166
1st Codon : 1
A V A A I W V A S V V F S T L F I A Y Y D H V A V L L C L V
GCCGTGCGCGTATCTGGGTGGCTAGCGTCGTGTTTAGCACACTGTTTATCGCTTACTATGACCATGTGGCTGTGCTCCTGTGTCTGGTC

Gene : MC1R
Segment# : 13
Offset : 181
1st Codon : 1
F I A Y Y D H V A V L L C L V V F F L A M L V L M A V L Y V
TTCTATGGCTATTACGATCAOGTCGCGTCTGCTCTGCTCGTGGTCTTCTTCTGGCTATGCTCGTGTCTCATGGCTGTGCTCTACGTC

Gene : MC1R
Segment# : 14
Offset : 196
1st Codon : 1
V F F L A M L V L M A V L Y V H M L A R A C Q H A Q G I A R
GTGTTTTCTCGCATGCTGGTCTGTATGGCCGCTCTGTATGTGCATATGCTCGCCAGAGCCCTGTGAGCATGCCCAAGGCATTGCCAGA

Gene : MC1R
Segment# : 15
Offset : 211
1st Codon : 1

Figure 27 (Cont)

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H M L A R A C Q H A Q G I A R L H K R Q R P V H Q G F G L K
CACATGCTGGCTAGGGCTTGCCAAACAGCTCAGGGAATCGCTAGGCTCCACAAAAGGCAAAGGCTGTGCATCAGGGATTCCGACTGAA

Gene : MC1R

Segment# : 16

Offset : 226

1st Codon : 1

L H K R Q R P V H Q G F G L K G A V T L T I L L G I F F L C
CTGCATAAGAGACAGAGACCGTCCACCAAGGCTTTGGCCTCAAGGGAGCCGTCACCCCTCACCATTCTGCTCGGCATTTTCTTTCTGTGT

Gene : MC1R

Segment# : 17

Offset : 241

1st Codon : 1

G A V T L T I L L G I F F L C W G P F F L H L T L I V L C P
GGCGCTGTGACACTGACAACTCCTCTGGGAATCTTTTCCTCTGCTGGGGCCCTTCTTCTGCATCTGACACTGATGTGTCTGCCCCCT

Gene : MC1R

Segment# : 18

Offset : 256

1st Codon : 1

N G P F F L H L T L I V L C P E H P T C G C I F K N F N L P
TGGGACCCCTTTTCTCCACCTCACCCTCATGCTCTGTGTCCGGAACACCCCTACCTGTGGCTGTATCTTTAAGAATTTCAATCTGTTT

Gene : MC1R

Segment# : 19

Offset : 271

1st Codon : 1

E H P T C G C I F K N F N L F L A L I I C N A I I D P L I Y
GAGCATCCACATGCGGATGCATTTTCAAAAACCTTTAACTCTTCCTCGCCCTCATCATTTGCAATGCCATTATCGATCCCTCATCTAT

Gene : MC1R

Segment# : 20

Offset : 286

1st Codon : 1

L A L I I C N A I I D P L I Y A F H S Q E L R R T L K E V L
CTGGCTCTGATTATCTGTAACTATCATTGACCTCTGATTACGCTTTCCATAGCCAAGAGCTCAGGAGAACCCCTCAAGGAAGTGCTC

Gene : MC1R

Segment# : 21

Offset : 301

1st Codon : 1

A F H S Q E L R R T L K E V L T C S W A A
GCCTTTCACTCCAGGAAGTGAAGGACTGAAAGAGGTCTTGACATGCTCTGGGCTGCC

Gene : MUC1P

Segment# : 1

Offset : 1

1st Codon : 1

A A M T P G T Q S P F F L L L L L T V L T V V T G S G H A S
CCGCTATGACACCGGAACCCAAAGCCCTTTCTTTCTGCTCTGCTCTGACAGTGCTCACCGTGTGACAGGCTCCGGCCATGCCTCC

Gene : MUC1P

Segment# : 2

Offset : 16

1st Codon : 1

L L T V L T V V T G S G H A S S T P G G E K E T S A T Q R S
CTGCTCACCGTCTGACAGTGGTCAACCGAAGCGGACAGCTAGCTCCACCCCTGGCGGAGAGAAAGAGACAAGCGCTACCCAAAGGTCC

Gene : MUC1P

Segment# : 3

Offset : 31

1st Codon : 1

S T P G G E K E T S A T Q R S S V P S S T E K N A V S M T S
AGCACACCGGAGCGGAAAAGGAAACCTCCGCCACACAGAGAAGCTCCGTGCTAGCTCCACCGAAAAGAAATGCCGTGAGCATGACCTCC

Gene : MUC1P

Segment# : 4

Offset : 46

1st Codon : 1

S V P S S T E K N A V S M T S S V L S S H S P G S G S S T T
AGCGTCCCTCCAGCACAGAGAAAACGCTGTGTCCATGACAAGCTCCGTGCTCAGCTCCCACTCCCCCGAAGCGGAAGCTCCACCACA

Figure 27 (Cont)

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Gene : MUC1P
Segment# : 5
Offset : 61
1st Codon : 1
S V L S S H S P G S G S S T T Q G Q D V T L A P A T E P A S
AGCGTCCTGTCCAGCCATAGCCCTGGCTCGGCTCCAGCACAACCCCAAGGCCAAGACGTCACCCCTCGCCCCCTGCCACAGAGCCTGCCTCC

Gene : MUC1P
Segment# : 6
Offset : 76
1st Codon : 1
Q G Q D V T L A P A T E P A S G S A A T W G Q D V T S V P V
CAGGACAGGATGTGACACTGGCTCCCGCTACCGAAACCCGCTAGCGGAAGCGCTGCCACATGGGGACAGGATGTGACAAGCGTCCCCGCTC

Gene : MUC1P
Segment# : 7
Offset : 91
1st Codon : 1
G S A A T W G Q D V T S V P V T R P A L G S T T P P A H D V
GGCTCGCGCGTACCTGGGGCCAAGACGTCACCTCCGTGCTGTGACAAGGCCCTGCCCTCGGCTCCACCACACCCCTGCCCATGACGCTC

Gene : MUC1P
Segment# : 8
Offset : 106
1st Codon : 1
T R P A L G S T T P P A H D V T S A P D N K A A
ACCGAGCCCGTCTCGGAAGCACAAACCCCTCCCGCTCAGCATGTGACAAGCGCTCCCGATAACAAAGCGCT

Gene : MUC1R
Segment# : 1
Offset : 1
1st Codon : 1
A A N R P A L G S T A P P V H N V T S A S G S A S G S A S T
CGCGCTAACAGACCCGCTCTGGGAAGCACAGCCCCCTCCCGTCCAATGTGACAAGCGCTAGCGGAAGCGCTAGCGGAAGCGCTAGCACA

Gene : MUC1R
Segment# : 2
Offset : 16
1st Codon : 1
N V T S A S G S A S G S A S T L V H N G T S A R A T T T P A
AAGCTCACCTCCGCTCCGGCTCCGCTCCGCTCCGCTCCACCTCTGTCATAACGGAACTCCGCCAGAGCCACAACCAACCCGCT

Gene : MUC1R
Segment# : 3
Offset : 31
1st Codon : 1
L V H N G T S A R A T T T P A S K S T P P S I P S H H S D T
CTGGTCCAATGGCACAAGCGCTAGGGCTACCACAACCCCTCGCCTCCAAGTCCAACCCCTTCTCCATCCCTAGCCATCACTCCGACACA

Gene : MUC1R
Segment# : 4
Offset : 46
1st Codon : 1
S K S T P P S I P S H H S D T P T T L A S H S T K T D A S S
AGCAAAAGCACACCTTTAGCATTCCTCCCAACCATAGCGATACCCCTACCACACTGGCTAGCCATAGCACAAGACAGACGCTAGCTCC

Gene : MUC1R
Segment# : 5
Offset : 61
1st Codon : 1
P T T L A S H S T K T D A S S T H H S S V P P L T S S N H S
CCCAACCCCTCGCTCCCACTCCACCAAAACCGATGCTCCAGCACACCATAGCTCCGTGCTCCCTCCCTCACCTCCAGCAATCACTCC

Gene : MUC1R
Segment# : 6
Offset : 76
1st Codon : 1
T H H S S V P P L T S S N H S T S P Q L S T G V S P P P L S
ACCCATCACTCCAGCGTCCCCCTCTGACAAGCTCCAACCATAGCACAAGCCCTCAGCTCAGCACAGGCGTCAGCTTTTCTTTCTGTCTC

Gene : MUC1R

Figure 27 (Cont)

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Segment# : 7
Offset : 91
1st Codon : 1
T S P Q L S T G V S P F F L S P H I S N L Q P N S S L E D P
ACCTCCCCCACTGTCCACCGGAGTGTCTTCTTTTCTCAGCTTTCACATTAGCAATCTGCAATTCAATAGTCCCTGGAAGACCT

Gene : MUC1R
Segment# : 8
Offset : 106
1st Codon : 1
F H I S N L Q P N S S L E D P S T D Y Y Q E L Q R D I S E M
TTCCATATCTCCAACCTCCAGTTAACTCCAGCCTCGAGGATCCCTCCACCGATTACTATCAGGAACTGCAAAGGGATATCTCCGAGATG

Gene : MUC1R
Segment# : 9
Offset : 121
1st Codon : 1
S T D Y Y Q E L Q R D I S E M F L Q I Y K Q G G F L G L S N
AGCACAGACTATTACAAAGAGCTCCAGAGAGACATTAGCGAAATGTTCTGCAAATCTATAAGCAAGGCGGATTCTCGGCCTCAGCAAT

Gene : MUC1R
Segment# : 10
Offset : 136
1st Codon : 1
F L Q I Y K Q G G F L G L S N I K F R P G S V V V Q L T L A
TTCTCCAGATTACAAACAGGGAGGCTTTCTGGGACTGTCCAACATTAACTTTAGGCCTGGCTCCGTGGTCTGTCAACTGACACTGGCT

Gene : MUC1R
Segment# : 11
Offset : 151
1st Codon : 1
I K F R P G S V V V Q L T L A F R E G T I N V H D V E T Q F
ATCAAATTCAGACCCGGAAGCGTCTGGTCCAGCTCACCCCTCGCTTTAGGGAAGGCACAATCAATGTGCATGACGTGAGACACAGTTT

Gene : MUC1R
Segment# : 12
Offset : 166
1st Codon : 1
F R E G T I N V H D V E T Q F N Q Y K T R A A S R Y N L T I
TTCAGAGAGGAACCAATTAACGTCCAAGATGTGGAACCCAATTCAATCAGTATAAGACAGAGGCTGCCTCCAGGTATAACCTCACCATT

Gene : MUC1R
Segment# : 13
Offset : 181
1st Codon : 1
N Q Y K T E A A S R Y N L T I S D V S V S D V P P P P S A Q
AACCAATACAAAACCGAGCGCTAGCAGATACAATCTGACAACTCCGACGTACAGGTACAGATGTGCCTTTCCCTTTCTCGGCCAA

Gene : MUC1R
Segment# : 14
Offset : 196
1st Codon : 1
S D V S V S D V P P P P S A Q S G A G V P G W G I A L L V L
AGCGATGTGTCGTGTCGAGCTCCCTTTCCCTTTAGGCTCAGTCCCGGCTGGCGTCCCGGATGGGAATCGCTCTGCTCGTCTC

Gene : MUC1R
Segment# : 15
Offset : 211
1st Codon : 1
S G A G V P G W G I A L L V L V C V L V A L A I V Y L I A L
AGCGGAGCCGAGTGCCTGGCTGGGGCATTGCCCTCCTGGTCTGGTCTGGTCCCTCGCCATGTGTATCTGATTGCCCTC

Gene : MUC1R
Segment# : 16
Offset : 226
1st Codon : 1
V C V L V A L A I V Y L I A L A V C Q C R R K N Y G Q L D I
GTGTGTGTGCTCGTCTCTGGCTATCGTCTACCTCATCGCTCTGGCTGTGTGTAGTGTAGGAGAAAGATTACGGACAGCTCGACATT

Gene : MUC1R
Segment# : 17
Offset : 241

Figure 27 (Cont)

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1st Codon : 1

A V C Q C R R K N Y G Q L D I F P A R D T Y H P M S E Y P T
GCGCTCTGCCAATGCAGAGGAAAACTATGGCCAACTGGATATCTTTCCCGCTAGGGATACCTATCACCTATGTCCGAGTATCCACA

Gene : MUC1R

Segment# : 18

Offset : 256

1st Codon : 1

F P A R D T Y H P M S E Y P T Y H T H G R Y V P P S S T D R
TTCCCTGCCAGAGACACATACCATCCCATGAGCGAATACCTACCTATCACACACCGGAAGGTATGTGCTCCCTCCAGCACAGACAGA

Gene : MUC1R

Segment# : 19

Offset : 271

1st Codon : 1

Y H T H G R Y V P P S S T D R S P Y E K V S A G N G G S S L
TACCATACCCATGGCAGATAGTCCCGCTAGCTCCACCGATAGGTCCCGCTAAGAGAAAGTGTCCGCGGAAACGGAGGCTCCAGCCTC

Gene : MUC1R

Segment# : 20

Offset : 286

1st Codon : 1

S P Y E K V S A G N G G S S L S Y T N P A V A A A S A N L A
AGCCCTTACGAAAGGTGAGCGCTGGCAATGGCGGAAGCTCCCTGTCTACACAAACCTGCGGTGCGCGCTGCTCCGCAATCTGGCT

Gene : MUC1R

Segment# : 21

Offset : 301

1st Codon : 1

S Y T N P A V A A A S A N L A A
AGCTATACCAATCCCGCTGTGGCTGCGCGCTAGCGCTAACCTGCGCGCT

Segments in scrambled order:

gp100 #4

W N R Q L Y P E W T E A Q R L D C W R G G Q V S L K V S N D
TGGAATAGGCAACTGTATCCGAATGGACAGAGGCTCAGAGACTGGATTGCTGGAGGGGAGGCCAAGTGTCCCTGAAAGTGTCCAACGAT

TRP2 #6

P Y I L R N Q D D R E L W P R K P F H R T C K C T G N F A G
CCCTATATCCTCAGGAATCAGGATGACAGAGACTCTGGCTTAGGAATTCITTCACAGAACCTGTAGTGTACCGGAACCTTTGCCGGA

Tyros #30

R N G D F P I S S K D L G Y D Y S Y L Q D S D P D S P Q D Y
AGGAATGGCGATTCTTTATCTCCAGCAAGAACTCGGCTATGACTATAGCTATCTGCAAGACTCCGACCTGACTCCTTCCAAGACTAT

TRP-1 #1

A A P A F L T W H R Y H L L R L E K D M Q E M L Q E P S F S
GCGCTCCCGCTTCTCTACCTGGCAGATACCATCTGCTCAGGCTGAGAAAGACATGCAGGAAATGCTCCAGGAACCTCCTCTCTCC

Tyros #29

G H N R E S Y M V P F I P L Y R N G D F P I S S K D L G Y D
GGCCATAACAGAGAGTCTACATGGTGCTTTCAITCCCTCTACAGAAACGGAGACTTTTTCATTAGCTCCAAGGATCTGGGATACGAT

TRP2 #16

L L C L E R D L Q R L I G N E S F A L P Y W N F A T G R N E
CTGCTCTGCTCGAGAGAGACCTCCAGAGACTGATTGGCAATGAGTCTTGCCTCTGCTTACTGGAACCTTGCCACAGGCAGAAACGAA

gp100 #23

T T E V V G T T P G Q A P T A E P S G T T S V Q V P T T E V
ACCACAGAGGCTGCTGGGAACCAACCGGACAGGCTCCACAGCCGAACCTCCGGCACAACTCCGTGCAAGTGCCTACCACAGAGGTC

MUC1R #9

S T D Y Y Q E L Q R D I S E M F L Q I Y K Q G G F L G L S N
AGCAGAGACTATTACCAAGAGCTCCAGAGAGACATTAGCGAAATGTTTCTGCAAATCTATAAGCAAGCGGATCTCCGCGCTCAGCAAT

gp100 #36

A C M E I S S P G C Q P P A Q R L C Q P V L P S P A C Q L V
GCGTGTATGGAAATCTCCAGCCCTGGCTGTACGCTCCCGCTCAGAGACTGTGTACGCTGTGCTCCCGCTCCCGCGCTTGCCAACCTGGTC

TRP2 #31

D Q L G Y S Y A I D L P V S V E E T P G W P T T L L V V M G

Figure 27 (Cont)

GACCAACTGGGATACTCCTACGCTATCGATCTGCCTGTGTCCGTGGAAGAGACACCCGGATGGCCTACCACACTGCTCGTGGTCAATGGGA

TRP-1 #7

TRP2 #3

MUC1R #13

TRP2 #1

gp100 #18

qsp100 #27

MUC1R #11

MUCIF #7

MC1R #16

MCLR #20

TRP2 #7**TRP2 #23**

MUC1R #4

MUC1R #1

TRP2 #21

MUC1R #6

MC1R #13

Tyros #16

K L T G D B N F T I P Y W D W R D A E K C D I C T D E Y M G

Figure 27 (Cont)

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AAGCTCACCGGAGACGAAAACCTTTACCATTCCTATTGGGATTGGAGAGACGCTGAGAAATGCGATATCTGTACCGATGAGTATATGGGA

gp100 #32

L R L V K R Q V P L D C V L Y R Y G S F S V T L D I V Q G I
CTGAGACTGGTCAAGAGACAGGTCCCCCTCGACTGTGTGCTCTACAGATACGGAAGCTTTAGCGTCACCCCTGACATTGTGCAAGGCATT

MUC1R #10

F L Q I Y K Q G G P L G L S N I K F R P G S V V V Q L T L A
TTCTCCAGATTACAAACAGGGAGGCTTTCTGGGACTGTCCAACATTAAAGTTTAGGCCTGGCTCCGTGGTCTGCAACTGACACTGGCT

MC1R #9

V I D V I T C S S M L S S L C P L G A I A V D R Y I S I F Y
GTGATGAGCTCATCATGCTCCAGCATGTGTCCAGCCTCTGCTTTCTGGGAGCCATTGCCGTGACAGATACATTAGCATTTTCTAT

Tyros #21

R N P G M H D K S R T P R L P S S A D V E F C L S L T Q Y E
AGGAATCCCGGAAACCATGACAAAAGCAGAACCCTAGGCTCCCTCCAGCGCTGACGTGAGTTTTCCTCAGCCTCACCCAATACGAA

TRP-1 #14

F D E W L R R Y N A D I S T F P L E M A P I Q H N R Q Y N M
TTCGATGAGTGGCTGAGAGGTATAACGCTGACATTAGCACATTCCCTCTGGAAGGCTCCCATTTGCCATAACAGACAGTATAACATG

gp100 #39

V S L A D T N S L A V V S T Q L I M P G Q E A G L G Q V P L
GTGTCCCTGGCTGACACAACTCCCTGGCTGTGGTCAGCACACAGCTCATCATGCCGGACAGGAAGCCGACTGGGACAGGTCCCCCTC

gp100 #20

G P V T A Q V V L Q A A I P L T S C G S S P V P G T T D G H
GCCCTGTGACAGCCCAAGTGGTCCCTGCAAGCCGCTATCCCTCTGACAAGCTGTGGCTCCAGCCCTGTGCTGGCACAACOGATGGCCAT

Tyros #8

K F G F W G P N C T E R R L L V R R N I F D L S A P E K D K
AAGTTTGGCTTTTGGGACCCCAATTGCACAGAGAGAAGGCTCCTGGTCAGGAGAAACATTTTCGATCTGTCCGCCCTGAGAAAGACAAA

gp100 #13

L G T H T M E V T V Y H R R G S R S Y V P L A H S S S A P T
CTGGGAACCCATACCATGGAGGTACCGTCTACCATAGGAGAGGCTCCAGTCTCTACGTCCCCCTCGCCCATAGCTCCAGCGCTTTCACA

MC1R #12

A V A A I W V A S V V F S T L F I A Y Y D H V A V L L C L V
GCCGTGGCCGTATCTGGGTGGCTAGCGTGTGTTTAGCACACTGTTTATCGCTTACTATGACCATGTGGCTGTGCTCCTGTGTCTGGTC

TRP2 #25

G T L D S Q V M S L H N L V H S F L N G T N A L P H S A A N
GGCACACTGGATAGCCCAAGTGATGAGCCTCCACAATCTGGTCCACTCCTCCTCAACGGAACCAATGCCCTCCCCCATAGCGCTGCCAAT

MART #4

G C W Y C R R R R N G Y R A L M D K S L H V G T Q C A L T R R
GGCTGTGTGTTATTCAGAGGAGAAACGGATACAGAGCCCTCATGGATAAGTCCCTGCAATGTGGGAACCAATGCGCTCTGACAAGGAGA

Tyros #15

P W H R L F L L R W E Q E I Q K L T G D E N F T I P Y N D W
CCCTGGCACAGACTGTTTCTGCTCAGGTGGGAGCAAGAGATTAGAACTGACAGGCGATGAGAAATTCACAATCCCTTACTGGGACTGG

MC1R #1

A A M A V Q G S Q R R L L G S L N S T P T A I P Q L G L A A
GCCGTATGGCTGTGCAAGGCTCCAGAGAGGCTCCTGGGAAGCCTCAACTCCACCCCTACCGCTATCCCTCAGCTGGGCTCGCCGCT

MC1R #5

V V A T I A K N R N L H S P M Y C F I C C L A L S D L L V S
GTGTGCCCAATCGCTAAGAATAGGAATCTGCATAGCCCTATGTATTGCTTTATCTGTGTGCTGGCCCTCAGCGATCTGCTGTGTCTC

Tyros #25

Q S S M H N A L H I Y M N G T M S Q V Q G S A N D P I P L L
CAGTCCAGCATGCACAAATGCCCTCCACATTTACATGAACGGAACCATGAGCCCAAGTCAAGGCTCCGCCAATGACCCCTATCTTTCTGCTC

Tyros #18

G Q H P T N P N L L S P A S F F S S W Q I V C S R L E E Y N
GGCCAACACCTACCAATCCCAATCTGCTCAGCCCTGCCCTCCTTCTTTAGCTCCTGGCAAATCGTCTGCTCCAGGCTCGAGGAATACAAAT

MC1R #6

Y C F I C C L A L S D L L V S G T N V L E T A V I L L L E A

Figure 27 (Cont)

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TACTGTTTCATTTGCTGTCTGGCTCTGTCCGACCTCCTGGTCAGCGGAACCAATGTGCTCGAGACAGCCGTCATCCTCTGCTCGAGGCT

TRP2 #19

D P T L I S R N S R F S S W E T V C D S L D D Y N H L V T L
GACCCCTACCCCTCATCTCCAGGAATAGCAGATTCTCCAGCTGGGAGACAGTGTGTGACTCCCTGGATGACTATAACCATCTGGTCACCCCTC

MUC1F #8

T R P A L G S T T P P A H D V T S A P D N K A A
ACCAAGACCCGCTCTGGGAAGCACAAACCCCTCCCGCTCAGATGTGACAAGCGCTCCCGATAACAAAGCCGCT

Tyros #17

R D A E K C D I C T D E Y M G G Q H P T N P N L L S P A S F
AGGGATGCCGAAAAGTGTGACATTTGCACAGACGAATACATGGGCGGACAGCATCCCAAAACCCCTAACCTCCTGTCCCGCTAGCTTT

gp100 #17

T F A L Q L H D P S G Y L A E A D L S Y T W D F G D S S G T
ACCTTTGCCCTCCAGCTCCACGATCCCTCCGGCTA...CTGGCTGAGGCTGACCTCAGCTATACCTGGGACTTTGGCGATAGCTCCGGCACA

Tyros #22

S S A D V B F C L S L T Q Y E S G S M D K A A N F S P R N T
AGCTCCGCCGATGTGGAATTCTGTCTGTCCCTGACACAGTATGAGTCCGGCTCCATGGATAAGGCTGCCAATTTCTCCTTCAGAAACACA

gp100 #6

G P T L I G A N A S P S I A L N F P G S Q K V L P D G Q V I
GGCCCTACCCCTCATCGGAGCAATGCCCTCTCTCCATGGCTCTGAATTTCCCTGGCTCCCGAGAAAGTCTCCCGATGGCCAAAGTGATT

MC1R #18

W G P F F L H L T L I V L C P E H P T C G C I F K N F N L F
TGGGGACCCCTTTTCTCCACCTCACCCCTCATCGTCCCTGTGTCCCGAACCCCTACCTGTGGCTGTATCTTTAAGAATTTCAATCTGTTT

Tyros #7

C Q C S G N F M G F N C G N C K F G P W G P N C T E R R L L
TGCCAAATGCTCCGGCAATTTTCATGGGCTTTAACTGTGGCAATTGCAAATTCGGATTCTGGGGCCCTAACTGTACCGAAAGGAGACTGCTC

TRP2 #34

Q Y R R L R K G Y T P L M E T H L S S K R Y T E E A A A
CAGTATAGGAGACTGACAAAGGGATACACACCCCTCATGGAAACCCATCTGTCCAGCAAAAGGTATACCGAAGAGGCTGCCGCT

TRP-1 #15

P L E N A P I G H N R Q Y N M V P P W P P V T N T E M F V T
CCCCCTGAGAATGCCCTATCGGACACAATAGGCAATACAATATGGTCCCTTTTGGCCCTCCCGTCACCAATACCGAAATGTTTGTGACA

gp100 #7

N P P G S Q K V L P D G Q V I W V N N T I I N G S Q V W G G
AACTTTCCCGGAAGCCAAAGGTCTGCTGACGGACAGGTCTCTGGGTGAATAACACAATCATTAAACGGAAGCCAAAGTGTGGGGGCGCA

gp100 #22

R P T A E A P N T T A G Q V P T T E V V G T T P G Q A P T A
AGGCCTACCGCTGAGGCTCCCAATACACAGCCGGACAGGTCCCAACAACGAAGTGGTGGGACACAACCCCTGGCCAGCCCTACCGCT

MUC1F #3

S T P G G E K E T S A T O R S S V P S S T E K N A V S M T S
AGCACACCCGGAGGCGAAAGGAAACCTCCGCCACACAGAGAAGCTCCGTGCTAGCTCCACCGAAAGAATGCCGTGAGCATGACCTCC

gp100 #42

L I Y R R R L M K Q D F S V P Q L P H S S S H W L R L P R I
CTGATTTACAGAAGGAGACTGATGAAGCAAGACTTTAGCGTCCCCCACTGCCTCACTCCAGCTCCCACTGGCTGAGACTGCCCTAGGATT

TRP2 #12

L G L L G P N G T Q P Q F A N C S V Y D F F V W L H Y Y S V
CTGGGACTGCTCGGCCCTAACGGAACCCCAACCCCAATTCGCTAACTGTAGCGTCTACGATTTCTTTGTGTGGCTGCATTACTATAGCGTC

TRP-1 #9

C L E V G L P D T P P F Y S N S T N S P R N T V E G Y S D P
TGCCTCGAGGTGGGCTCTTCGATACCCCTCCCTTTTACTCCAACCTCCACCAATAGCTTTAGGAATACCGTGGAGGGGATCTCCGACCCCT

gp100 #1

A A M D L V L K R C L L H L A V I G A L L A V G A T K V P R
GCGCTATGGATCTGGTCTGAAAGGTGTCTGCTCCACCTCGCGCTCATCGGAGCCCTCCTGGCTGTGGAGCCACAAGGTCCCGAGA

MC1R #3

N Q T G A R C L E V S I S D G L F L S L G L V S L V E N A L

Figure 27 (Cont)

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AACCAAACCGAGCCAGATGCCTCGAGGTCAGCATTAGCGATGGCCTCTTCTCAGCCTCGGCCTCGTGTCCCTGGTCGAGAATGCCCTC

Tyros #23

S G S M D K A A N F S P R N T L E G F A S P L T G I A D A S
AGCGGAAGCATGGACAAAGCCGCTAACTTTAGCTTTAGGAATACCTCGAGGGATTGCTAGCCCTCTGACAGGCATTGCCGATGCCCTC

Tyros #4

S P C G Q L S G R G S C Q N I L L S N A P L G P Q P P F T G
AGCCCTTGGCGACAGCTCAGCGGAAGGGGAAGCTGTGAGAATATCCTCTGTCCAACGCTCCCTCGGCCCTCAGTTTCCCTTTACCGGA

Tyros #13

M H Y Y V S M D A L L G G S E I W R D I D F A H E A P A F L
ATGCATTACTATGTGTCCATGGATGCCCTCCTGGGAGGCTCCGAGATTGGAGAGACATTGACTTTGCCCATGAGGCTCCCGCTTTCCTC

Tyros #35

E E K Q P L L M E K E D Y H S L Y Q S H L A A
GAGGAAAAGCAACCCCTCCTGATGGAGAAAGAGGATTACCATAGCCTCTACCAAAGCCATCTGGCTGCC

TRP2 #5

G Q C T E V R A D T R P W S G P Y I L R N Q D D R E L W P R
GCCCAATGCACAGAGGTGAGGCTGACACAAGGCCTTGGTCCGGCCCTTACATTCTGAGAAACCAAGACGATAGGGAACGTGGGCCAGA

MUC1P #4

S V P S S T E K N A V S M T S S V L S S H S P G S G S S T T
AGCGTCCCTCCAGCACAGAGAAAACGCTGTGTCCATGACAAGCTCCGTGCTCAGCTCCCACTCCCCCGGAAGCGGAAGCTCCACCACA

Tyros #12

T P M F N D I N I Y D L F V W M H Y Y V S M D A L L G G S E
ACCCCTATGTTTAAAGATATCAATATCTATGACCTCTCGTCTGGATGCACTATTACGTGAGCATGGACGCTCTGCTCGGCGGAAGCGAA

gp100 #9

Q P V Y P Q E T D D A C I F P D G G P C P S G S W S Q K R S
CAGCCTGTGTATCCCAAGAGACAGACGATGCCTGTATCTTCCCGATGGCGGACCTGTCCCTCGGCTCCTGGTCCAGAAAAGGTCC

TRP-1 #6

D S L E D Y D T L G T L C N S T E D G P I R R N P A G N V A
GACTCCCTGGAGACTATGACACACTGGGAACCCCTCTGCAATAGCACAGAGGATGGCCCTATCAGAAGGAATCCCGCTGGCAATGTGGCT

gp100 #8

W V N N T I I N G S Q V W G G Q P V Y P Q E T D D A C I F P
TGGGTCAACAATACCATTATCAATGGCTCCAGGTCTGGGGAGGCCAACCGTCTACCCCTCAGGAAACCGATGACGCTTGCAATTTCCCT

MART #7

Q E K N C B P V V P N A P P A Y E K L S A E Q S P P P Y S P
CAGGAAAAGAAATGCGAACCGCTGCTGCTTAACGCTCCCCCTGCCTATGAGAAACGTCCGCGAAGAGTCCCCCCTCCCTATAGCCCT

gp100 #14

S R S Y V P L A H S S S A F T I T D Q V P F S V S V S Q L R
AGCAGAAGCTATGTGCCCTCTGGCTCACTCCAGCTCCGCTTTTACCATTACCGATCAGGTCCCTTTAGCGTCAGCGTCAGCCAACAGGA

TRP-1 #2

L E K D M Q E M L Q E P S F S L P Y W N P A T G K N V C D I
CTGGAAGAGATATGCAAGAGATGCTGCAAGAGCCTAGCTTTAGCCTCCCTATTGGAATTTGCTACCCGAAAGAAATGTGTGTGACATT

TRP-1 #16

V P F W P P V T N T E M F V T A P D N L G Y T Y E A A
GTGCCCTTTCTGGCCCCCTGTGACAAACACAGAGATGTTGCTCACCGCTCCCGATAACCTCGGCTATACCTATGAGGCTGCC

TRP2 #13

C S V Y D F F V W L H Y Y S V R D T L L G P G R P Y R A I D
TGCTCCGTGTATGACTTTTCTGCTGGCTCCACTATTACTCCGTGAGAGACACACTGCTCGGCCCTGGCAGACCCTATAGGGCTATCGAT

Tyros #9

V R R N I F D L S A P R K D K F P A Y L T L A K H T I S S D
GTGAGAAGGAATATCTTTGACCTCAGCGCTCCCGAAAAGGATAAGTTTTTCTGCTTACCTCACCTCGCCAAACACACAATCTCCAGCGAT

MART #2

K K G H G H S Y T T A E E A A G I G I L T V I L G V L L L I
AAGAAAGGCCATGGCCATAGCTATACCACAGCCGAAGAGGCTGCCGGAATCGGAATCCTCACGTCATCCTCGGCGTCTGCTCCTGATT

gp100 #11

P V Y V W K T W G Q Y W Q V L G G P V S G L S I G T G R A M

Figure 27 (Cont)

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TTCGTCTACGTCTGGAAAACTGGGGCCAATACTGGCAGGTCCTGGGAGGCCCTGTGTCCGGCCTCAGCATTGGCACAGGCAGAGCCATG

gp100 #12

G G P V S G L S I G T G R A M L G T H T M E V T V Y H R R G
GGCGGACCCGTGAGCGGACTGTCCATCGGAACCGGAAGGGCTATGCTCGGCACACACACAATGGAAGTGACAGTGTATCACAGAAGGGGA

gp100 #25

I S T A P V Q M P T A E S T G M T P E K V P V S E V M G T T
ATCTCCACCGCTCCCGTCCAGATGCCACAGCCGAAAGCACAGGCATGACCCCTGAGAAAGTGCTGTGTCCGAGGTCAATGGGAACCA

Tyros #19

F S S W Q I V C S R L E E Y N S H Q S L C N G T P E G P L R
TTCTCCAGCTGGCAGATTGTGTGTAGCAGACTGGAAGAGTATAACTCCCAACAAAGCCCTCTGCAATGGCACACCCGAAGGCCCTCTGAGA

TRP2 #27

D P I F V V L H S P T D A I F D E W M K R F N P P A D A W P
GACCCATATCTTTGTGGTCTGCTATAGCTTTAC GATGCCATTTTCGATGAGTGGATGAAAGGTTTAACCTCCCGCTGAGCGCTTGGCT

MC1R #15

H M L A R A C Q H A Q G I A R L H K R Q R P V H Q G F G L K
CACATGCTGGCTAGGGCTTGCCAACAGCTCAGGGAAATCGCTAGGCTCCACAAAGGCAAGGCCCTGTGCATCAGGGATTGGACTGAAA

MUC1F #2

L L T V L T V V T G S G H A S S T P G G E K E T S A T Q R S
CTGCTCACCGTCTGACAGTGGTCAACCGAAGCGGACAGCTAGCTCCACCCCTGGCGGAGAGAAAGACAGCGCTACCCAAAGGTCC

gp100 #44

F C S C P I G E N S P L L S G Q Q V A A
TTCTGTAGCTGTCCCATTTGGGAAAACTCCCCCTCTGTGTCCGGCCAACAGGTGCGCGT

TRP2 #24

T P S P R N A L E G F D K A D G T L D S Q V M S L H N L V H
ACCTTTAGCTTTAGGAATGCCCTCGAGGGATTGCGATAAGGCTGACGGAACCCCTGACTCCAGGTCAATGTCCCTGCATAACCTCGTGCAT

Tyros #20

S H Q S L C N G T P E G P L R R N P G N H D K S R T P R L P
AGCCATCAGTCCCTGTGTAAAGGAACCCCTGAGGGACCCCTCAGGAGAAACCCCTGGCAATCAGATAAGTCCAGGACACCCAGACTGCT

TRP2 #30

P F F P P V T N E E L F L T S D Q L G Y S Y A I D L P V S V
CCCTTTTCCCTCCCGTCACCAATGAGGAAGTGTCTGTGACAAAGGATCAGCTCGGCTATAGCTATGCCATTGACCTCCCGTCAGCGTC

TRP2 #9

E R K K P P V I R Q N I H S L S P Q E R E Q F L G A L D L A
GAGAGAAAGAAACCCCTGTGATTAGGCAAAACATTCACTCCCTGTCCCCCAAGAGAGAGCAATTCTCTGGCGCTCTGGATCTGGCT

TRP2 #29

Q E L A P I G H N R M Y N M V P F P P P V T N E E L F L T S
CAGGAAGTGGCTCCCATTTGGCCATAACAGAATGTATAACATGGTGCCCTTTCTTTCCCTCTGTGACAAAGAGAGCTCTTCTCACCTCC

gp100 #28

E V S I V V L S G T T A A Q V T T T E W V E T T A R E L P I
GAGGTGAGCATTGTGGTCTGTCCGGCACACCGCTGCCCCAAGTGACAACCAAGAGTGGGTGGAACCAAGCCAGAGAGCTCCCCATT

MUC1R #7

T S P Q L S T G V S F P F L S P H I S N L Q P N S S L E D P
ACCTCCCCCAACTGTCCACGGAGTGTCTTTCTTTTCTCTCAGCTTTCACATTAGCAATCTGCAATTCAATAGCTCCCTGGAAGACCTT

MUC1R #19

Y H T H G R Y V P P S S T D R S P Y E K V S A G N G G S S L
TACCATACCATGGCAGATAGTCCCCCTAGCTCCACCGATAGGTCCCCCTATGAGAAAGTGTCCGCGGAAACGGAGGCTCCAGCCTC

MC1R #4

L F L S L G L V S L V E N A L V V A T I A K N R N L H S P M
CRGTTTCTGTCCCTGGGACTGGTCAGCTCGTGAAACGCTCTGGTGTGGCTACCATTTGCCAAAAACAGAAACCTCCACTCCCCCATG

TRP2 #26

S F L N G T N A L P H S A A N D P I F V V L H S P T D A I F
AGCTTTCTGAATGGCAGAAAGCTCTGCTCACTCCGCGCTAAGCATCCCATTTCTGTGTGTCTCCACTCCTTCACAGAGCTATCTTT

MUC1R #17

A V C Q C R R K N Y G Q L D I P P A R D T Y H P M S E Y P T

Figure 27 (Cont)

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GCGCTCTGCCAATGCAGAAGGAAAACTATGGCCAACCTGGATATCTTTCCGCTAGGGATACCTATCACCCCTATGTCCGAGTATCCCA

MC1R #14

V P P L A M L V L M A V L Y V H M L A R A C Q H A Q G I A R
GTGTTTTTCCTCGCCATGCTGGTCTGTATGGCCGCTCTGTATGTGCATATGCTCGCCAGAGCCTGTCAGCATGCCCAAGGCATGCCCAGA

TRP-1 #10

S T N S F R N T V E G Y S D P T G K Y D P A V R S L H N L A
AGCACAACTCCTTCAGAAACACAGTGGAGGCTATAGCGATCCACAGGCAATACGATCCCGCTGTGAGAAGCCTCCACAATCTGGCT

TRP-1 #3

L P Y W N F A T G K N V C D I C T D D L M G S R S N F D S T
CTGCCTTACTGGAACCTTTGCCACAGGCAAAAACGCTCTGCATATCTGTACCGATGACCTCATGGGAAGCAGAAGCAATTTGATAGCACA

gp100 #15

I T D Q V P F S V S V S Q L R A L D G G N K H F L R N Q P L
ATCACAGACCAAGTGCCCTTTCTCGGTGTCGCTGCCAGCTCAGGGCTCTGGATGGGGAAACAACTTTCTGAGAAACCAACCCCTC

MUC1R #8

F H I S N L Q F N S S L E D P S T D Y Y Q E L Q R D I S E M
TTCCATATCTCCAACTCCAGTTTAACTCCAGCCTCGAGGATCCCTCCACCGATTACTATCAGGAACGCAAGGGATATCTCCGAGATG

MUC1R #20

S P Y E K V S A G N G G S S L S Y T N P A V A A A S A N L A
AGCCCTTACGAAAGGTGAGCGCTGGCAATGGCGGAAGCTCCCTGTCTACACAAACCTGCGGTGCGCGCTGCCCTCCGCAATCTGGCT

Tyros #11

Y V I P I G T Y G Q M K N G S T P M F N D I N I Y D L F V W
TAGCTCATCCCTATCGGAACCTATGGCCAAATGAAAAACGGAAGCACACCCATGTTCAATGACATTAACTTTACGATCTGTTGTGTGG

gp100 #37

R L C Q P V L P S P A C Q L V L H Q I L K G G S G T Y C L N
AGGCTCTGCCAACCCGCTCCTGCTAGCCCTGCTGTGCTGCTCCACCAATCTCTCAAGGGAGGCTCCGGCACAATCTGTCTGAAT

gp100 #33

R Y G S F S V T L D I V Q G I E S A E I L Q A V P S G E G D
AGGTATGGCTCCTTCTCGTGACACTGGATATCGTCCAGGAATGAAAGCGCTGAGATTCTGCAAGCCGTCCTCCGCGGAAGGCGAT

Tyros #27

H H A F V D S I F E Q M L Q R H R P L Q E V Y P E A N A P I
CACCATGCCCTTTGTGGATAGCATTTTCGAACAGTGGCTGCAAGGCATAGGCCTCTGCAAGAGGTCTACCTGAGGCTAACGCTCCCAT

TRP-1 #4

C T D D L M G S R S N F D S T L I S P N S V P S Q W R V V C
TGACAGAGCATCTGTATGGCTCCAGSTCCAACCTTTGACTCCACCTCATCTCCCCCAATAGCGTCTTCTCCAGTGGAGGCTGTGTGT

MUC1R #18

P P A R D T Y H P M S E Y P T Y H T H G R Y V P P S S T D R
TTCCCTGCCAGACACATAACCTCCCATGAGCGAATACCTTACCTATCACACACAGGAAGGTATGTGCCCTCCCTCCAGCACAGACAGA

MUC1R #21

S Y T N P A V A A A S A N L A A
AGCTATACCAATCCCGCTGTGGCTGCCGCTAGCGCTAACCTGCGCGCT

MC1R #19

E H P T C G C I F K N F N L F L A L I I C N A I I D P L I Y
GAGCATCCACATGCGGATGCATTTTCAAAAACCTTTAACTCTTCTCGCCCTCATCATTGCAATGCCATTATCGATCCCTCATCTAT

Tyros #26

M S Q V Q G S A N D P I F L L H H A P V D S I F E Q M L Q R
ATGTCACAGGTCCAGGGAAGCGCTAACGATCCCATTTTCTCTCTGCATCAGCTTTGCTGACTCCATCTTTGAGCAATGGCTCCAGAGA

TRP2 #22

R N S M K L P T L K D I R D C L S L Q K F D N P P F P Q N S
AGGAATAGCATGAAGCTCCCCACACTGAAGACATTAGGGATTGCTCAGCCTCCAGAAATTCGATAACCCCTCCCTTTTCCAAAACCTCC

gp100 #19

L I S R A L V V T H T Y L E P G P V T A Q V V L Q A A I P L
CTGATTAGCAGAGCCCTCGTGGTCAACCATACCTATCTGGAACCGGACCGCTCACCGCTCAGGTGCTGCTCCAGGCTGCCATTCCTCCTC

TRP2 #17

S F A L P Y W N F A T G R N E C D V C T D Q L F G A A R P D

Figure 27 (Cont)

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AGCTTTGCCCTCCCTATTGGAATTTGCTACCGGAAGGAATGAGTGTGACGTCTGCACAGACCAACTGTTTGGCGCTGCCAGACCCGAT

gp100 #2

V I G A L L A V G A T K V P R N Q D W L G V S R Q L R T K A
GTGATTGGCGCTCTGCTCGCGCTGGCGCTACCAAAGTGCTTAGGAATCAGGATTGGCTGGCGCTCAGCAGACAGCTCAGGACAAAGGCT

gp100 #16

A L D G G N K H F L R N Q P L T F A L Q L H D P S G Y L A E
GCCCTCGACGGAGGCAATAAGCATTTCCTCAGGAATCAGCCTCTGACATTGCTCTGCAACTGCATGACCTAGCGGATACCTCGCCGAA

TRP2 #18

C D V C T D Q L F G A A R P D D P T L I S R N S R F S S W E
TCCGATGTGTGTACCGATCAGCTCTCGGAGCGCTAGGCTGACGATCCACACTGATTAGCAGAAACTCCAGGTTTAGCTCTGGGAA

MART #1

A A M P R E D A H F I Y G Y P K K G H G H S Y T T A E E A A
GCCGATATGCTAGGGAAGACGCTCACTTTATCTATGGCTATCCCAAAAGGGACACGGACACTCCTAAGCTAGGGAAGCCGCT

TRP-1 #11

T G K Y D P A V R S L H N L A H L F L N G T G G Q T H L S S
ACCGAAAGTATGACCGCTGCCGTCAGGTCCCTGCATAACCTGGCCCATCTGTTTCTGAATGGCACAGGCGGACAGACACCTCAGCTCC

MUC1R #14

S D V S V S D V P F P P S A Q S G A G V P G W G I A L L V L
AGCGATGTGTCCGTGTCCGACGCTCCCTTTCCCTTTAGCGCTCAGTCCGGCGCTGGCGTCCCGGATGGGAATCGCTCTGCTGCTGCTC

TRP2 #10

S P Q E R E Q F L G A L D L A K K R V H P D Y V I T T Q H W
AGCCCTCAGGAAAGGGAACAGTTTCTGGGAGCCCTCGACCTCGCCAAAAGAGAGTGATCCCGATTACGTATCACAACCCACACTGG

Tyros #10

P F A Y L T L A K H T I S S D Y V I P I G T Y G Q M K N G S
TTCTTTGCTATCTGACACTGGCTAAGCATACCATTAGCTCCGACTATGTGATTCCCATTTGGCACATACGGACAGATGAAGATGGCTCC

MUC1R #7

G T N V L E T A V I L L L E A G A L V A R A A V L Q Q L D N
GGCACAAACGTCCTGGAAACCGCTGTGATTCTGCTCTGGAGCGGAGCCCTCGTGGCTAGGGCTGCCGTCTGCAACAGCTCGACAAT

MUC1R #16

V C V L V A L A I V Y L I A L A V C Q C R R K N Y G Q L D I
GTGTGTGTGCTGTGGCTCTGGCTATGCTACCTCATCGCTCTGGCTGTGTGTGTCAGTGTAGGAGAAAGAATTACGGACAGCTCGACATT

MART #6

C P Q E G F D H R D S K V S L Q E K N C E P V V P N A P P A
TGCCCTCAGGAAGGCTTTGACCATAGGGATAGCAAGTGTCCTTGCAAGAGAAAAGTGTGAGCCTGTGGTCCCAATGCCCTCCCGCT

MUC1F #5

S V L S S H S P G S G S S T T Q G Q D V T L A P A T E P A S
AGCGTCTGTCCAGCCATAGCCCTGGCTCGGCTCAGCACAAACCAAGGCCAAGAGCTCACCTCGCCCTGCCACAGAGCTGCTCC

TRP2 #28

D E W M K R F N P P A D A W P Q E L A P I G H N R M Y N M V
GACGAATGGATGAAGAGATTCAATCCCCCTGCCGATGCTGGCCCCAAGAGCTCGCCCTATCGGACACAATAGGATGTACAATATGGTC

MUC1R #21

A F H S Q E L R R T L K E V L T C S W A A
GCCTTTCACTCCAGGAACCTGAGAAGGACACTGAAAGAGGTCTGACATGCTCCTGGGCTGCC

TRP2 #15

F S H Q G P A F V T W H R Y H L L C L E R D L Q R L I G N E
TTCTCCCAAGGCCCTGCTTTGTGACATGGCATAGGTATCACCTCCTGTGCTGGAAGGGATCTGCAAGGCTCATCGGAACGAA

TRP-1 #8

R P M V Q R L P E P Q D V A Q C L E V G L F D T P P P Y S N
AGCCCTATGGTCCAGAGACTGCCCTAGCCTCAGGATGTGGCTCAGTGTCTGGAAGTGGGACTGTTTGACACACCCCTTTCTATAGCAAT

TRP-1 #13

Q D P I F V L L H T P T D A V F D E W L R R Y N A D I S T P
CAGGATCCCATTTTCTGCTCTCCACACATTACAGACGCTGTGTTTGACGAATGGCTCAGGAGATACAATGCCGATATCTCCACCTTT

TRP2 #4

L G A E S A N V C G S Q Q G R G Q C T E V R A D T R P M S G

Figure 27 (Cont)

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CTGGGAGCCGAAAGCGCTAACGTCTGCGGAAGCCAAACAGGGAAGGGGACAGTGTACCGAAGTGAGAGCCGATACCAGACCCCTGGAGCGGA

TRP2 #8

Y N C G D C K F G W T G P N C E R K K P P V I R Q N I H S L
TACAATTGCGGAGACTGTAAAGTTTGGCTGGACCGGACCCCAATTGCGAAAGGAAAAAGCCTCCCGTCATCAGACAGAATATCCATAGCCTC

TRP-1 #12

H L P L N G T G G Q T H L S S Q D P I F V L L H T P T D A V
CAGCTCTTCTCTCAACGGAACCGGAGGCCAAACCCATCTGTCCAGCCAAGACCCCTATCTTTGTGCTCTGCATACCTTTACCGATGCCGCTC

Tyros #34

G L V S L L C R H K R K Q L P E E K Q P L L M E K E D Y H S
GGCCTCGTGTCCCTGCTCTGCAGACACAAAGGAAACAGCTCCCGAAGAGAAACAGCCTCTGCTCATGGAAGGAAGACTATCACTCC

TRP2 #2

G C K I L P G A Q G Q F P R V C M T V D S L V N K E C C P R
GGCTGTAAGATTCTGCTGGCGCTCAGGGAAGCTTCCAGAGTGTGTATGACAGTGGATAGCCTCGTGAATAAGGAATGCTGTCCCGA

gp100 #43

Q L P H S S S H W L R L P R I F C S C P I G E N S P L L S G
CAGCTCCCCCATAGCTCCAGCCATTGGCTCAGGCTCCCCAGAACTTTTGTCTCTGCCCTATCGGAGAGAATAGCCCTCTGCTCAGCGGA

gp100 #10

D G G P C P S G S W S Q K R S F V Y V W K T W G Q Y W Q V L
GACGAGGCCCTTGGCTAGCGGAAGCTGGAGCCAAAGAGAAGCTTTGTGTATGTGTGGAAGACATGGGGACAGTATTGGCAAGTGCTC

gp100 #3

N Q D W L G V S R Q L R T K A W N R Q L Y P E W T E A Q R L
AACCAGACTGGCTGGGAGTGTCCAGGCACTGAGAACCAAGCCTGGAACAGACAGCTCTACCCCTGAGTGGACCGAAGCCCAAGGCTC

Tyros #14

I W R D I D F A H E A P A F L P W H R L F L L R W E Q E I Q
ATCTGGAGGGATATCGATTTCGCTCAGGAAGCCCTGCTTTCTGCTCTGGCATAGGCTCTTCTCTCTGAGATGGGAACAGGAATCCAA

MUC1F #1

A A M T P G T Q S P F P L L L L L T V L T V V T G S G H A S
GCCGTATGACACCCGGAACCCAAAGCCCTTCTTCTGCTCTGCTCTGACAGTGTCTACCGTCTGTGACAGGCTCCGGCCATGCTCTC

MART #5

D K S L H V G T Q C A L T R R C P Q E G F D H R D S K V S L
GACAAAGCCTCCAGCTCGGCACACAGTGTGCCCTCACCAGAAGGTGTCCCAAGAGGGATTGATCACAGAGACTCCAAGGTGAGCCTC

MUC1R #2

N V T S A S G S A S G S A S T L V H N G T S A R A T T T P A
AACGTCACTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCTCCGCT

Tyros #24

L E G F A S P L T G I A D A S Q S S M H N A L H I Y M N G T
CTGGAAGGCTTTGCTTCCCCCTCAGCGAATCGCTGACGCTAGCCAAAGCTCCATGCATAAGCCTCTGCATATCTATATGAATGGCACA

TRP2 #14

R D T L L G P G R P Y R A I D F S H Q G P A F V T W H R Y H
AGGGATACCTCTCTGGGACCGGAAGGCCCTTACAGAGCCATTGACTTTAGCCATCAGGGACCGGCTTTCTGTCACCTGGCACAGATACCAT

Tyros #1

A A M L L A V L Y C L L W S F Q T S A G H F P R A C V S S K
GCCGTATGCTCTCTGCTGTGCTCTACTGTCTGCTCTGGTCTTCCAAACCTCCGCGGACACTTTCCAGAGCCTGTGTGTCCAGCAAA

gp100 #35

A F E L T V S C Q G G L P K E A C M E I S S P G C Q P P A Q
GCCCTTGAGCTCAGCGTCAGCTGTGAGGAGGCCCTCCCCAAGAGGCTTGCAATGGAGATTAGCTCCCCCGGATGCCAACCCCTGCCCAA

Tyros #6

V D D R E S W P S V F Y N R T C Q C S G N F M G P N C G N C
GTGGATGACAGAGAGTCTGGCCTAGCGTCTTCTATAACAGAACTGTGAGTGTAGCGGAACCTTTATGGGATTCAATTGCGGAACCTGT

gp100 #34

E S A E I L Q A V P S G E G D A F E L T V S C Q G G L P K E
GAGTCCGCGAATCTCCAGGCTGTGCTAGCGGAGAGGAGAGCGCTTTCGAACCTGACAGTGTCTGCCAAGGCGGACTGCTTAAGGAA

TRP2 #20

T V C D S L D D Y N H L V T L C N G T Y E G L L R R N Q M G

Figure 27 (Cont)

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ACCGTCTGCGATAGCCTCGACGATTACAATCACCTCGTGACACTGTGTAACGGAACTATGAGGGACTGCTCAGGAGAAACCAATGGGA

Tyros #5

L L S N A P L G P Q F P F T G V D D R E S W P S V F Y N R T
CTGCTCAGCAATGCCCTCTGGGACCCCAATTCCTTTTCAAGCGCTCGACGATAGGGAAGCTGGCCCTCCGTGTTTTCAATAGGACA

MART #8

Y E K L S A E Q S P P P Y S P A A
TACGAAAAGCTCAGCGCTGAGCAAAGCCCTCCCCCTTACTCCCCCGCTGCC

gp100 #41

I V G I L L V L M A V V L A S L I Y R R R L M K Q D F S V P
ATGCTGGCATTCTGCTCGTGCATAGGCTGTGGTCTGGCTAGCCTCATCTATAGGAGAAGGCTCATGAAACAGGAITTTCTCCGTGCCT

MART #3

G I G I L T V I L G V L L L I G C W Y C R R R R N G Y R A L M
GGCATTGGCATTCTGACAGTGATTCTGGGAGTGCCTGCTCATCGATGCTGGTACTGTAGGAGAAGGAATGGCTATAGGCTCTGATG

Tyros #31

Y S Y L Q D S D P D S F Q D Y I K S Y L E Q A S R I W S W L
TACTCTACCTCCAGGATAGCGATCCGATAGCTTTTCAAGATTACATTAGTCTACCTCGAGCAAGCCTCCAGGATTGGTCTGGCTC

MUC1F #6

Q G Q D V T L A P A T E P A S G S A A T W G Q D V T S V P V
CAGGGACAGGATGTGACACTGGCTCCCGCTACCGAAACCCGCTAGCGGAAGCGCTGCCACATGGGGACAGGATGTGACAAGCGTCCCCGCT

gp100 #21

T S C G S S P V P G T T D G H R P T A E A P N T T A G Q V P
ACCTCTGCGGAAGCTCCCCGCTCCCGGAACCAAGACGGAACAGACCCACAGCCGAAGCCCTTAACACAACCGCTGGCCAAGTGCCT

MUC1R #3

L V H N G T S A R A T T T P A S K S T P F S I P S H H S D T
CTGGTCCCAATGGCACAAGCGCTAGGGCTACCACAACCCCTGCCTCCAAGTCCACCCCTTTCTCCATCCCTAGCCATCACTCCGACACA

TRP2 #32

E E T P G W P T T L L V V M G T L V A L V G L F V L L A P L
GAGGAAACCCCTGGCTGGCCCAACCCCTCTGGTGTGATGGGCACACTGGTCCGCCCTGGTGGGACTGTTGTGCTCCTGGCTTTCTCT

gp100 #29

T T T E W V E T T A R E L P I P E P E G P D A S S I M S T E
ACCACAACCGAATGGGTGAGACAAACCGCTAGGGAAGTGCCTATCCCTGAGCCTGAGGGACCGATGCCCTCCAGCATTATGTCCACCGAA

MUC1R #17

G A V T L T I L L G I F P L C W G P F P L H L T L I V L C P
GGCGCTGTGACACTGACAATCTCTCTGGGAATCTTTTCTCTGCTGGGGCCCTTTCTTTCTGCACTGACACTGATTGTGCTCTGCCCT

Tyros #33

L G A A M V G A V L T A L L A G L V S L L C R H K R K Q L P
CTGGGAGCGCTATGGTGGGCTGTGCTCAGCGCTCTGCTCGCGGACTGGTCAAGCTCCTGTGTAGGCATAAGAGAAAGCACTGCCT

MUC1R #8

G A L V A R A A A V L Q Q L D N V I D V I T C S S M L S S L C
GGCGCTCTGGTCCAGAGCCGCTGTGCTCCAGCAACTGGATAACGTATCATGTGATTACCTGTAGCTCCATGCTCAGCTCCCTGTGT

gp100 #26

M T P E K V P V S E V M G T T L A E M S T P E A T G M T P A
ATGACACCCGAAAAGGTCCCGTCAAGCAAGTATGGGCACAAACCTCGCCGAAATGTCCACCCCTGAGGCTACCGGAATGACACCCGCT

Tyros #2

Q T S A G H F P R A C V S S K N L M E K E C C P P W S G D R
CAGACAAGCGCTGGCCATTTCCCTAGGGCTTGGTCAAGTCTGATGGAGAAAGAGTGTGCCCCCTCCCTGGAGCGGAGACAGA

MUC1R #11

A L R Y H S I V T L P R A P R A V A A I W V A S V V F S T L
GCCCTCAGGTATCACTCCATGCTACCCCTCCCGAGAGCCCTAGGGCTGTGGCTGCCATTGGGTGCGCTCCGTGGTCTTCTCCACCCCT

MUC1R #12

P R E G T I N V H D V E T Q F N Q Y K T E A A S R Y N L T I
TTCAAGAGGGAAACCATTAACGTCCAGATGTGGAAACCAATCAATCAGTATAAGACAGAGGCTGCCCTCCAGGTATAACCTCACCATT

Tyros #3

N L M E K E C C P P W S G D R S P C G Q L S G R G S C Q N I

Figure 27 (Cont)

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AACCTCATGGAAGGAATGCTGTCCCTTGGTCCGGCGATAGGTCCCCTGTGGCCAACTGTCCGGCAGAGGCTCCTGCCAAACATT

Tyros #32

IKSYLEQASRIWSNLLGAAMVGA VLTALLA
ATCAAAGCTATCTGGAACAGGCTAGCAGAATCTGGAGCTGGCTCTGGCGCTCCATGCTGGGAGCGCTCTGACAGCCCTCTGGCT

MUC1R #5

PTTLASHSTKTDA SSTHHSSVPLTSSSNHS
CCCAACCCCTCGCTCCCACTCCACAAAACCGATGCTCCAGCACACCATAGCTCCGTGCTCCCTTCACCTCCAGCAATACCTC

MUC1R #15

S G A G V P G N G I A L L V L V C V L V A L A I V Y L I A L
AGCGGAGCCGGAGTGCCTGGCTGGGGCATTGCCCTCCTGGTCCTGGTCGTCTGGTCGCCCTCGCCATFGTGTAATCGAATGCCCTC

MCIR #10

FLNGAIAVDRIYSIFYALRYHSIVTLPRAPR
TTCTCGGGCGCTATCGCTGGATAGGTATATCTCCATCTTTTACGCTCTGAGATACCATAGCATTGTGCACTGCCTAGGGCTCCACAGA

gp100 #40

L I M P G Q E A G L L G Q V P L I V G I L L V L M A V V L A S
CTGATTATGCGCTGGCCAAGAGGCTGGCGCTCGGCCAAGTGCTCTGATTGTGGGAATCTCTCTGGTCTCATGGCCGTCGTGCTCGCCTCTC

TRP2 #33

T L V A L V G L P V L L A P L Q Y R R L R K G Y T P L M E T
 ACCCTCGTGGCTCTGGTGGCCCTCTTCGTCTCTGCTGCCCTTCTGCAATACAGAAGGCTCAGGAAGGCTATACCCCTCTGATGGAGACA

TRP-1 #5

LI SPNSV F S QWRVVCDSL E D Y D T L G T L C N S
CTGATTAGCCCTAACTCCGTGTTTAGCCAATGGAGAGTGGTCTCGATAGCCTCGAGGATTACGATACCTCCGGCACACTGTGTAACTC

MCI R #2

CTGAATAGCACACCCACAGCCATTCCCCAACTGGGACTGGCTGCCAATCAGACAGGCGCTAGGTGCTCGGAAGTCTCCATCTCCGACGGA

Tyros #28

H R P L Q E V Y P E A N A P I G H N R E S Y M V P F I P L Y
 CACAGACCCCTCCAGGAAGTGATCCCGAAGCCCAATGCCCTATCGGACACAATAGGGAAAGCTATATGGTCCCCTTTATCCCTCTGTAT

gp100 #24

E P S G T T S V Q V P T T R V I S T A P . V Q M P T A E S T G
 GAGCCTAGCGGAACCAAGCGTCCAGGTCCCCACACCGAGTGATTAGCACAGCCCCCTGTGCMAATGCCTACCGCTGAGTCCACCGGA

TRP2 #11

K K R V H P D Y V I T T Q H W L G L L G P N G T Q P Q F A N
A G A A A A G G G T C C A C C C T G A C T A T G T G A T T A C C A C A G A C A T T G G C T C G G C C T C C T G G G A C C C A A T G G C A C A C A G C C T C A G T T T G C C A A T

gp100 #38

L H Q I L K G G S G T Y C L N V S L A D T W S L A V V S T Q
CTGCATCAGATTCTGAAGGCGGAAGCGGAACCTATTGCGCTCAAGCTCAGCCTCGCGGATACCAATAGCCTCGCGGTGTGTCCACCCAA

gp100 #30

P E P E G P D A S S I M S T E S I T G S L G P L L D G T A T
 CCGAACC CGAAGGCCCTGA GCTAGCTCCATCATGAGCAGAGTCCATCAGAGGCTCCCTGGGACCCCTCCTGGATGGCAGACCCCA

qp100 #31

S I T G S L G P L L D G T A T L R L V K R Q V P L D C V L Y
AGCATTACCGGAAGCCTCGGCCCTCTGCTCGACGGAACCGCTACCCTCAGCCTCGTGAAAAGCCAGTGCCTCTGGATTGCGTCTGTAT

qp100 #5

D C W R G G Q V S L K V S N D G P T L I G A N A S P S I A L
GACTGTTGGAGAGGGCGGACAGGTTCAGCTCAAGGTACGATGAACGACCCACACTGATTGGCGCTAACGCTAGCTTTAGCTATTCCTTC

Synthetic Protein:

WNRQLYPEWTEAQRLLDCNRGGQVSLKVSNDPYILIRNQDORELMPKYPFHRTCKCTGNFAGRNGDFFISSKDLGYDYSYLQSDPDSPQDYAAPFLTW
HRYHLRLRLKDLQMLQRPFSCHNRRESYVHPFPLPYRNGDFFISSKDLGYDILCLERDLQRLIGNESFALPYWNFPATGRNETTEVVGTTPGQAPTA
PSGTTTSVQVPTTEVSTDYYQELRDISFPLQYIKYGGQFLGLSNACHEISSGQCPAPQARLQCPVLPSPACQVLDQLGYSAIYDLFVSVEPTFGWVT
LIVVMGTEDGPIRIRNPAGNVRPMVQRLPBPQDVACHTVDSLIVNKECCPRFAGSABANVCGSQQRNRYQKTEAASRYNLTISDVSVDVPPPSAQAA
HSPLMWGPLLSCIGCKLPGAQGGPFRVADLSYTWDPGDSGTLISRALVVTHTYLEPLAEMSTPEATGMTPAEVSIVVLSGTTAAQVIKFRPGSVVV
QLTLAFREGTINVHDVETQPSAATMGQDVTVSVTPRALGZSTPPAHDHPPKRRPVHQGFGLKGAVTLTILIGIFPLCLIALIICNAIIDPLIYAPH
SQRRLRLKEVLKFPHRTCKCTGNFAGRNGDCTGTYGNCPLSLQKFDNPPFQNSTPFRNALGGLKADKSDTSPISHSHTPTTLTASHSTKT
DASSAANRPAIGSTAPVPHNVTSAGSAGSASTCNGTYBGLLRNMGGRNSMKLPTLKDTRDCTHVSVPPLTSSNHSTSPOLSTGSPFLSSFLPAY

Figure 27 (Cont)

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[illegible]

Synthetic DNA:

TGGAATAGGCAACTGTATCCCGAATGGACAGAGGCTCAGAGACTGGATTGCTGGAGGGGAGGCCAAGTGTCCCTGAAAGTGTCCAACGATCCCTATAT
CCTCAGGAATCAGGATGACAGACAGCTCTGGCCCTAGGAAATCTTTCACAGAACTGTAAAGTGTACCGGAATCTGCGGGAAGGAATGGCGAATTTCT
TTATCTCCAGCAAGACCTCGGCTATGACTATAGCTATCTGCAAGACTCCGACCTGACTCTTCCAGACTATGCGGCTCCCGCTTTCTCTCACTCGG
CAGAGATACCATCTGCTCAGGCTCGAGAAAGCATGCAGGAAATGCTCCAGAACCTCCCTCTTCCAGGCTATACAGAGAGTCTCATAGGTCCTTT
CATTCCTCTCTACAGAAACGGAGACTTTTCTATAGCTCCAAGGATCTGGGATAGCATCTGCTCTGCTCGAGAGAGAGCTCCAGAGACTGATTGGCA
ATGAGCTCTTCCCTCTGCTTTACTGGAACTTTGCCACAGGCAGAAACGAAACCCAGAGAGTGTGGGAGACCCAGCCGGAAGCTCCCAAGCGCGAA
CCCTCCGGACCAACTCCGTGCAGTGCTTACCAAGAGGTCAGCAGACATATTACCAAGAGCTCCAGAGAGACATACGGGAATGTGTTCTGCAAAAT
CTATAAGCAACCGGGATTTCTCGGCTCAGCAATGCCGTGATGGAAATCTCCAGCCCTGGCTGTGAGCTCCCGCTCAGAGACTGTGTGAGCTGTGC
TCCCTTCCCGCGCTGCTCCAACTGGTCGACCAACTGGGATACTCTACGCTATCGATCTGCTGTGCTGGTGAAGAGACACCGGATGGCTTACCA
CTGCTGTGTGTCTAGGGAACGGAAGACGACCACTTAGGAGAAACCTCCGCGAAAGCTGCCAGACCTAGTGTCGCAAGGCTCCCGGAACCCCAAGA
CGTGCCTCAATGCTAGACCGTGCATCTCCTGGTCAACAAAGAGTGTGCCCCTAGGCTCGGCGCTGAGTCCGCGCAATGTGTGTGGCTCCAGCAAGGCA
GAAACCAATACAAAGAGCGGCTAGCAGATACAACTGACAATCTCCGAGCTCAGGTCAGGATCGTGCTGCTTTCCCTTTCTCGCCCAAGCGGCT
ATGTCCCGCTCTGGTGGGGCTTTCTGCTCAGCTGTCTGGGATGCAAAATCTCCCGGAGCCCAAGGCCAATCTCCATGGGTGCGCGATCTGTCTTA
CACATGGGATTTCCGAGACTCCAGCGGAACCTCTATCTCCAGGGCTCTGGTGTGACACACATACCTCGAGCTCTGAGGTAGATGAGCACCGG
AAGCCACAGGCATGACCCCTCCGAGTGTTCATCTGTGCTCAGCGGAACCAAGCGCTCAGGTCATCAAATTCAGAACCCGGAAGCGTGTGTGTC
GAGCTCAGCTCGCCTTTAGGGAAGGCACAAATGTCATGAGTGCAGTGCAGACACAGTTTGGCTCCGCGCTCAGCTGGGGCCAAAGAGTCACTCCGT
CCTGTGACCAAGGGCTGCCCCGCTCCACACACACCCCTGCCATGACGTCCTGCATAGAGACAGAGACCTCCACCAAGGCTTTGGCTCTCAAGG
GAGCGGTACACCTCACCATTCTGCTCGGCAATTTCTTTCTGTGTCTGGCTCTGATTATCTGTAAGCGTATCAATTGACCCCTGATTATACGCTTTCCAT
AGCCAAAGAGCTCAGGAGAACCTCAAGGAATGTCAGATTTTCCATAGGACATGCAAAAGCAGGCAATTTCCGTGGCTATAAATGTCGGGATG
CAAAATCGGATGGACAGGCCCTAACTGTCTGTCTGTCGCAAAAGTTGACAATCCCCCTTTCTTCAGATAGCACATTTCTCTTCAGAAAGCGCTGTC

Figure 27 (Cont)

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[illegible]

Figure 27 (Cont)

Figure 27 (Cont)

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ATATGGTCCCTTTATCCCTCTGTATGAGCCTAGCGGAACCAACGCGTCCAGGTCCCCACAAACCGAAGTGATTAGCACAGCCCCCTGTGCAATGCCT
 ACCGCTGAGTCCACCGAAAGAAAAGGGTCCACCGCTGACTATGTGATTACCAACAGCATTGGCTCGGCTCCTGGGACCCAATGGCACAGCCTCA
 GTTTGCCAATCTGCATCAGATTCTGAAAGGCGGAAGCGGAACCTATTGCCTCAACGTCAGCCTCGCGGATACCAATAGCCTCGCGCTCGTGTCCACCC
 AACCGAACCAGGAGGCTGACGCTAGCTCCATCATGAGCACAGAGTCCATCACAGGCTCCCTGGGACCCCTCCTGGATGGCACAGCCACAAGCATT
 ACCGGAAGCCTCGGCTCTGCTGACGGAACCGCTACCCCTCAGGCTCGTGAAGGCAAGTGCCCTCTGGATTGCGTCTGTATGACTGTTGGAGAGG
 CGGACAGGTCAGCCTCAAGGTCAGCAATGACGGACCCACACTGATTGGCGCTAACGCTAGCTTTAGCATTGCCCTC

Melanoma cancer Specific Savine Scramble process

Scramble - Output File

Scramble version : 0.1 beta, 08/02/1999

Num. genes : 10

Num. segments : 121

Segment length : 30

Segment overlap : 15

Segments in original order:

Gene : BAGE
 Segment# : 1
 Offset : 1
 1st Codon : 1
 A A M A R A V F L A L S A Q L L Q A R L M K E E S P V V S
 CGCGCTATGGCTGCCAGAGCGCTCTCCTCGCCCTCAGCGCTCAGCTCCTGCAAGCCAGACTGATGAAGGAAGAGTCCCCCGTCTGCTCC

Gene : BAGE
 Segment# : 2
 Offset : 16
 1st Codon : 1
 L L Q A R L M K E E S P V V S W R L E P E D G T A L C F I F
 CTGCTCCAGGCTAGGCTCATGAAGAGGAAGCCCTGTGGTCAGCTGGAGGCTCGAGCCTGAGGATGGCACAGCCCTCTGCTTTATCTTT

Gene : BAGE
 Segment# : 3
 Offset : 31
 1st Codon : 1
 W R L E P E D G T A L C F I F A A
 TGGAGACTGGAACCCGAGAGCGGAACCGCTCTGTGTTTCATTTCGCTGCC

Gene : GAGE-1
 Segment# : 1
 Offset : 1
 1st Codon : 1
 A A M S W R G R S T Y R P R P R R Y V E P P E M I G P M R P
 CGCGCTATGTCCTGGAGAGGAGGAGACATACAGACCCAGACCCAGAGGTATGTGGAAACCCCTGAGATGATCGGACCCATGAGGCTT

Gene : GAGE-1
 Segment# : 2
 Offset : 16
 1st Codon : 1
 R R Y V E P P E M I G P M R P E Q F S D E V E P A T P E E G
 AGGAGATACGTGAGCCTCCCGAATGATTGGCCCTATGAGACCGAAGCAGTTTAGCGATGAGGTCCAGCCTGCCACACCGAAGAGGGA

Gene : GAGE-1
 Segment# : 3
 Offset : 31
 1st Codon : 1
 E Q F S D E V E P A T P E E G E P A T Q R Q D P A A A Q E G
 GAGCAATTCTCGACGAAGTGGAAACCGCTACCCCTGAGGAGGCGAACCGCTACCCAAAGGCAAGACCTGCGCTGCCCAAGAGGGA

Gene : GAGE-1
 Segment# : 4
 Offset : 46
 1st Codon : 1
 E P A T Q R Q D P A A A Q E G E D E G A S A G Q G P K P E A
 GAGCCTGCCACAGAGACAGGATCCCGCTCGCGCTCAGGAAGGCGAAGACGAAGGCGCTAGCGCTGGCCAAAGGCCCTAAGCCTGAGGCT

Gene : GAGE-1
 Segment# : 5
 Offset : 61
 1st Codon : 1

Figure 27 (Cont)

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E D E G A S A G Q G P K P E A D S Q E Q G H P Q T G C E C E
GAGGATGAGGGAGCCTCCGCCGACAGGGACCCAAACCGAAGCCGATAGCCAAGAGCAAGGCCATCCCAAACCGGATGCGAATGCGAA

Gene : GAGE-1
Segment# : 6
Offset : 76
1st Codon : 1

D S Q E Q G H P Q T G C E C E D G P D G Q E M D P P N P E E
GACTCCAGGAACAGGGACACCTCAGACAGGCTGTGAGTGTGAGGATGGCCCTGACGGACAGGAAATGGATCCCCCTAACCTGAGGAA

Gene : GAGE-1
Segment# : 7
Offset : 91
1st Codon : 1

D G P D G Q E M D P P N P E E V K T P E E E M R S H Y V A Q
GACGGACCCGATGGCCAAGAGATGGACCTCCCAATCCCGAAGAGGTCAAGACACCCGAAGAGGAAATGAGAAGCCATTACGTGCGCCAA

Gene : GAGE-1
Segment# : 8
Offset : 106
1st Codon : 1

V K T P E E E M R S H Y V A Q T G I L W L L M N N C F L N L
GTGAAAACCCCTGAGGAAGAGATGAGGTCCCACTATGTGGCTCAGACAGGCATTCTGTGGCTGCTCATGAATAACTGTTCTCTCAACCTC

Gene : GAGE-1
Segment# : 9
Offset : 121
1st Codon : 1

T G I L W L L M N N C F L N L S P R K P A A
ACCGGAATCCTCTGGCTCCTGATGAACAATTGCTTTCTGAATCTGTCCCCAGAAAGCCTGCCGCT

Gene : gp100In4
Segment# : 1
Offset : 1
1st Codon : 1

A A S W S Q K R S F V Y V W K T W G E G L P S Q P I I H T C
GCCCTAGCTGGAGCCAAAGAGAAGCTTTGTGTATGTGTGGAAGACATGGGGAGAGGGACTGCCTAGCCAAACCCATTATCCATACCTGT

Gene : gp100In4
Segment# : 2
Offset : 16
1st Codon : 1

T W G E G L P S Q P I I H T C V Y F F L P D H L S F G R P F
ACCTGGGGCGAAGGCCTCCCTCCAGCCTATCATTACACATGGCTCTACTTTTCTCTCCCGATCACCTCAGCTTTGGCAGACCCCTT

Gene : gp100In4
Segment# : 3
Offset : 31
1st Codon : 1

V Y F P L P D H L S F G R P F H L N F C D F L A A
GTGTATTCTTTCTGCCCTGACCATCTGTCTTCCGGAAGSCCTTCCATCTGAATTTCTGTGACTTTCTGGCTGCC

Gene : MAGE-1
Segment# : 1
Offset : 1
1st Codon : 1

A A M S L E Q R S L H C K P E E A L E A Q Q E A L G L V C V
GCCGCTATGTCCCTGGAACAGAGAAGCCTCCACTGTAGCCTGAGGAAGCCCTCGAGGCTCAGCAAGAGGCTCTGGGACTGGTCTCGCTC

Gene : MAGE-1
Segment# : 2
Offset : 16
1st Codon : 1

E A L E A Q Q E A L G L V C V Q A A T S S S S P L V L G T L
GAGGCTCTGGAAGCCCAACAGGAAGCCCTCGGCCCTGTGTGTGTGAAGCCGCTAGCTCCAGCTCCAGCCCTCTGGTCTCGGAACCCCTC

Gene : MAGE-1
Segment# : 3
Offset : 31
1st Codon : 1

Q A A T S S S S P L V L G T L E E V P T A G S T D P P Q S P
CAGGCTGCCAAGCTCCAGCTCCCCCTCGTGCTCGGCACACTGGAAGAGGTCCCCACAGCGGAAGCACAGACCTCCCCAAGCCCTC

Figure 27 (Cont)

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Gene : MAGE-1
Segment# : 4
Offset : 46
1st Codon : 1
E E V P T A G S T D P P Q S P Q G A S A F P T T I N F T R Q
GAGGAAGTGCTACCGCTGGCTCCACGATCCCCCTCAGTCCCCCAAGGCGCTAGCGCTTTCCTACCAATCAATTTACAAGGCCAA

Gene : MAGE-1
Segment# : 5
Offset : 61
1st Codon : 1
Q G A S A F P T T I N F T R Q R Q P S E G S S S R E E E G P
CAGGGAGCCTCCGCTTTCCACAAACCTTAACCTTTACCAGACAGAGACAGCCTAGCGAAGGCTCCAGCTCCAGGGAGAGGAAGGCCCT

Gene : MAGE-1
Segment# : 6
Offset : 76
1st Codon : 1
R Q P S E G S S S R E E E G P S T S C I L E S L F R A V I T
AGCCAAACCTCCGAGGGAAGCTCCAGCAGAGAGGAAGAGGGACCTCCACCTCCTGCATTCTGGAAGCCTCTTCAGAGCCGTATCACA

Gene : MAGE-1
Segment# : 7
Offset : 91
1st Codon : 1
S T S C I L E S L F R A V I T K K V A D L V G F L L L K Y R
AGCACAAAGCTGTATCCCTCGAGTCCCTGTTTAGGGCTGTGATTACCAAAAAGGTGCGCGATCTGGTCCGCTTTCTGCTCCTGAAATACAGA

Gene : MAGE-1
Segment# : 8
Offset : 106
1st Codon : 1
K K V A D L V G F L L L K Y R A R E P V T K A E M L E S V I
AAGAAAGTGCTGACCTCGTGGGATTCTCTGCTCAAGTATAGGGCTAGGGAACCGTCACCAAGCCGAAATGCTCGAGTCCGTGATT

Gene : MAGE-1
Segment# : 9
Offset : 121
1st Codon : 1
A R E P V T K A E M L E S V I K N Y K H C F P E I F G K A S
GCCAGAGCCCTGTGACAAAGGCTGAGATGCTGGAAGCGTCATCAAAAATATAGCATTGCTTTCCGAAATCTTTGGCAAGCCCTCC

Gene : MAGE-1
Segment# : 10
Offset : 136
1st Codon : 1
K N Y K H C F P E I F G K A S E S L Q L V F G I D V K E A D
AAGAATTACAACACTGTTTCCCTGAGATTTCCGAAAGGCTAGCGAAAGCCTCCAGCTCGTGTGTTGGCATTGACGTCAAGGAAGCCGAT

Gene : MAGE-1
Segment# : 11
Offset : 151
1st Codon : 1
E S L Q L V F G I D V K E A D P T G H S Y V L V T C L G L S
GAGTCCCTGCCAATGCTCTTCGGAATCGATGTGAAAGAGGCTGACCCCTACCGGACACTCCTACGTCCTGGTCACCTGTCTGGGAGTCTCC

Gene : MAGE-1
Segment# : 12
Offset : 166
1st Codon : 1
P T G H S Y V L V T C L G L S Y D G L L G D N Q I M P K T G
CCCACAGGCCATAGCTATGTGCTCGTGACATGCTCGGCCCTCAGCTATGACGGACTGCTCGGCGATAACCAATCATGCCCAAAACCGGA

Gene : MAGE-1
Segment# : 13
Offset : 181
1st Codon : 1
Y D G L L G D N Q I M P K T G F L I I V L V M I A M E G G H
TACGATGGCCTCCTGGGAGACAATCAGATTATGCCTAAGACAGGCTTTCTGATTATCGTCTCGTTCATGATTGCCATGGAGGGAGGCCAT

Gene : MAGE-1

Figure 27 (Cont)

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Segment# : 14
Offset : 196
1st Codon : 1
F L I I V L V M I A M E G G H A P R E E I W E E L S V M E V
TTCCTCATCATTTGTCGTGTCGTATGCGCTATGGAAGGCGGACACGCTCCCGAAGAGGAAATCTGGGAGGAACTGTCGTGATGGAGGTC

Gene : MAGE-1
Segment# : 15
Offset : 211
1st Codon : 1
A P E E E I W E E L S V M E V Y D G R E H S A Y G E P R K L
GCCCTGAGGAAGAGATTGGGAAGAGCTCAGCGTCATGGAAGTGTATGACGGAAGGGAACACTCCGCCTATGGCGAACCCAGAAAGCTC

Gene : MAGE-1
Segment# : 16
Offset : 226
1st Codon : 1
Y D G R E H S A Y G E P R K L L T Q D L V Q E K Y L E Y R Q
TACGATGCGAGAGCATAGCGCTTAGCGAGAGCTAGGAAACTGCTACCCAGAGACCTCGTGCAAGAGAAATACCTCGAGTATAGGCAA

Gene : MAGE-1
Segment# : 17
Offset : 241
1st Codon : 1
L T Q D L V Q E K Y L E Y R Q V P D S D P A R Y E F L W G P
CTGACACAGGATCTGGTCCAGGAAAAGTATCTGGAATACAGACAGGTCCCGATAGCGATCCCGCTAGGTATGAGTTTCTGTGGGGCCCT

Gene : MAGE-1
Segment# : 18
Offset : 256
1st Codon : 1
V P D S D P A R Y E F L W G P R A L A E T S Y V K V L E Y V
GTGCGTACTCCGACCTGCCAGATACGAATTCTCTGGGGACCCAGAGCCCTGCGGAAACCTCTACGTCAAGGTCCGGAATACGTC

Gene : MAGE-1
Segment# : 19
Offset : 271
1st Codon : 1
R A L A E T S Y V K V L E Y V I K V S A R V R F F P P S L R
AGGGCTCTGGCTGAGACAAAGCTATGTGAAAGTCTCGAGTATGTGATTAAAGTTCAGCGCTAGGGTCAGGTTTTCTTTCCCTCCCTGAGA

Gene : MAGE-1
Segment# : 20
Offset : 286
1st Codon : 1
I K V S A R V R F P P P S L R E A A L R E E E E G V A A
ATCAAAGTGTCCGCCAGAGTGAGATTCTTTTCCCTAGCCTCAGGGAAGCCGCTCTGAGAGAGGAAGAGGAAGCGTCCCGCT

Gene : MAGE-3
Segment# : 1
Offset : 1
1st Codon : 1
A A M P L E Q R S Q H C K P E E G L E A R G E A L G L V G A
CCGCTATGCTCTGGAACAGAGAAGCCAACTGTAAAGCTGAGGAAGCCCTCGAGGCTAGGGGAGAGGCTCTGGGACTGGTCCGCGCT

Gene : MAGE-3
Segment# : 2
Offset : 16
1st Codon : 1
E G L E A R G E A L G L V G A Q A P A T E E Q E A A S S S S
GAGGACTGGAAGCCAGAGGCAAGCCCTCGGCTCTGGGAGCCCAAGCCCTGCCACAGAGGAACAGGAAGCGCTAGCTCCAGCTCC

Gene : MAGE-3
Segment# : 3
Offset : 31
1st Codon : 1
Q A P A T E E Q E A A S S S S T L V E V T L G E V P A A E S
CAGGCTCCGCTACCGAAGAGCAAGAGGCTGCTCCAGCTCCAGCACACTGGTCGAGGTACCCCTCGGGAAGTGCCCTGCGCTGAGTCC

Gene : MAGE-3
Segment# : 4
Offset : 46

Figure 27 (Cont)

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1st Codon : 1
T L V E V T L G E V P A A E S P D P P Q S P Q G A S S L P T
ACCTCGTGGAAAGTGACACTGGGAGAGGTCCCGCTGCCGAAAGCCCTGACCCCTCCCAAGCCCTCAGGGAGCCTCCAGCCTCCCCACA

Gene : MAGE-3
Segment# : 5
Offset : 61
1st Codon : 1
P D P P Q S P Q G A S S L P T T M N Y P L W S Q S Y E D S S
CCCGATCCCCCTCAGTCCCCCAAGGCGTAGCTCCCTGCCCTACCACAATGAATTACCTCTGTGGAGCCAAAGCTATGAGGATAGCTCC

Gene : MAGE-3
Segment# : 6
Offset : 76
1st Codon : 1
T M N Y P L W S Q S Y E D S S M Q E E E G P S T P P D L E S
ACCATGAATATCCCTCTGGTCCAGTCTACGAGACTCCAGCAATCAGGAAGAGGAAGGCCCTAGCAGATTCCCTGACCTCGAGTCC

Gene : MAGE-3
Segment# : 7
Offset : 91
1st Codon : 1
N Q E E E G P S T P P D L E S E P Q A A L S R K V A E L V H
AACCAGAGGAGAGGAGCCCTCCACCTTTCGGATCTGGAAAGCGAATCCAAGCCGCTCTGTCCAGGAAAGTGGCTGAGCTCGTGCAT

Gene : MAGE-3
Segment# : 8
Offset : 106
1st Codon : 1
E P Q A A L S R K V A E L V H F L L L K Y R A R E P V T K A
GAGTTTCAGGCTGCCCTCAGCAGAAAGGTGCGCAACTGGTCCACTTTCTGCTCCTGAAATACAGAGCCAGAGAGCCTGTGACAAAGGCT

Gene : MAGE-3
Segment# : 9
Offset : 121
1st Codon : 1
F L L L K Y R A R E P V T K A E M L G S V V G N W Q Y F P P
TTCTCCTGCTCAAGTATAGGGCTAGGGAACCGTCACCAAGCCGAAATGCTCGGCTCCGTTGGTGGCAATTGGCAATACTTTTCCCT

Gene : MAGE-3
Segment# : 10
Offset : 136
1st Codon : 1
E M L G S V V G N W Q Y F P P V I F S K A S S S L Q L V P G
GAGATGCTGGGAGCGTGGTGGGAACTGGCAGTATTCTTTCCTGCTACTTTAGCAAAGCCTCCAGCTCCCTGCAACTGGTCTTGGGA

Gene : MAGE-3
Segment# : 11
Offset : 151
1st Codon : 1
V I F S K A S S S L Q L V P G I E L M E V D P I G H L Y I F
GTGATTTTCTCCAAGGCTAGCTCCAGCCTCCAGCTCGTGTTTGGCAATTGAGCTCATGGAAGTGGATCCCATTTGGCCATCTGTATATCTTT

Gene : MAGE-3
Segment# : 12
Offset : 166
1st Codon : 1
I E L M E V D P I G H L Y I F A T C L G L S Y D G L L G D N
ATCGAACTGATGGAGGTGACCCCTATCGACACCTCTACATTTTCGCTACCTGTCTGGGACTGTCTACGATGGCCTCCTGGGAGACAAAT

Gene : MAGE-3
Segment# : 13
Offset : 181
1st Codon : 1
A T C L G L S Y D G L L G D N Q I M P K A G L L I I V L A I
GCCATATGCTCGGCTCAGCTATGACGACTGCTCGGCGATAACCAATCATGCCCAAAGCCGACTGCTCATCATTTGTGCTCGCCATT

Gene : MAGE-3
Segment# : 14
Offset : 196
1st Codon : 1
Q I M P K A G L L I I V L A I I A R E G D C A P E R K I N E

Figure 27 (Cont)

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CAGATTATGCCTAAGGCTGGCTCCTGATTATCGTCTGGCTATCATTGCCAGAGAGGGAGACTGTGCCCTGAGGAAAAGATTGGGAA

Gene : MAGE-3
Segment# : 15
Offset : 211
1st Codon : 1

I A R E G D C A P E E K I W E E L S V L E V F E G R E D S I
ATCGCTAGGGAAGGCGATTGGCTCCCGAAGAGAAAATCTGGGAGGAACTGTCCGTGCTCGAGGTCTTCCAAGGCAGAGAGGATAGCATT

Gene : MAGE-3
Segment# : 16
Offset : 226
1st Codon : 1

E L S V L E V F E G R E D S I L G D P K K L L T Q H F V Q E
GAGCTCAGCGTCTGGAAAGTGTGAGGGAAGGGAAGACTCCATCTCGCGATCCCAAAAAGCTCCTGACACAGCATTTCGTCCAGGAA

Gene : MAGE-3
Segment# : 17
Offset : 241
1st Codon : 1

L G D P K K L L T Q H F V Q E N Y L E Y R Q V P G S D P A C
CTGGGAGACCTAAGAACTGCTACCCAACACTTTGTGCAAGAGAATTACCTCGAGTATAGGCAAGTGCCTGGCTCCGACCCCTGCCCTGT

Gene : MAGE-3
Segment# : 18
Offset : 256
1st Codon : 1

N Y L E Y R Q V P G S D P A C Y E F L W G P R A L V E T S Y
AACTATCTGGAATACAGACAGGTCCCGGAAGCGATCCCGCTTGCTATGAGTTTCTGTGGGGCCCTAGGGCTCTGGTCGAGACAAGCTAT

Gene : MAGE-3
Segment# : 19
Offset : 271
1st Codon : 1

Y E F L W G P R A L V E T S Y V K V L H H M V K I S G G P H
TAGGAATCTCTGGGACCCAGAGCCCTCGTGGAACCTCTACGTCAAGTCTGCATCACATGGTGAAAATCTCCGGCGGACCCCAT

Gene : MAGE-3
Segment# : 20
Offset : 286
1st Codon : 1

V K V L H H M V K I S G G P H I S Y P P L H E W V L R E G E
GTGAAAGTGCTCCACCATATGGTCAAGATTAGCGGAGGCCCTCACATTAGCTATCCCCCTCTGCATGAGTGGGTGCTCAGGGAAGGCGAA

Gene : MAGE-3
Segment# : 21
Offset : 301
1st Codon : 1

I S Y P P L H E W V L R E G E E A A
ATCTCTACCTCCCTCCACGAATGGGTCTGAGAGAGGGAGAGGAAGCCGCT

Gene : PRAME
Segment# : 1
Offset : 1
1st Codon : 1

A A M E R R R R L W G S I Q S R Y I S M S V W T S P R R L V E
GCCGCTATGGAAAGGAGAAGGCTCTGGGAAGCATTTCAGTCCAGGTATATCTCCATGTCCGTGTGACCTCCCCAGAAAGGCTGTGGAA

Gene : PRAME
Segment# : 2
Offset : 16
1st Codon : 1

Y I S M S V W T S P R R L V E L A G Q S L L K D E A L A I A
TACATTAGCATGAGCGTCTGGACAAGCCCTAGGAGACTGGTCGAGCTGGCCGACAGTCCCTGCTCAAGGATGAGGCTCTGGCTATCGCT

Gene : PRAME
Segment# : 3
Offset : 31
1st Codon : 1

L A G Q S L L K D E A L A I A A L E L L P R E L F P P L F M
CTGGCTGGCCAAAGCCTCTGAAAGACGAAGCCCTCGCCATTGCCGCTCTGGAACGCTCCCCAGAGAGCTCTCCCTCCCTCTTCATG

Figure 27 (Cont)

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Gene : PRAME
Segment# : 4
Offset : 46
1st Codon : 1
A L E L L P R E L P P P L F M A A F D G R H S Q T L K A M V
GCCCTGAGCTCCTGCCTAGGGAACGTTCCTCCCTCTGTTTATGGCTGCCTTTGACGGAAGGCATAGCCAAACCTCAAGGCTATGGTC

Gene : PRAME
Segment# : 5
Offset : 61
1st Codon : 1
A A F D G R H S Q T L K A M V Q A W P F T C L P L G V L M K
GCCGCTTTGATGGCAGACACTCCACAGACTGAAAGCCATGGTGCAAGCCTGGCCCTTTACCTGTCTGCCTCTGGGAGTGCTCATGAAA

Gene : PRAME
Segment# : 6
Offset : 76
1st Codon : 1
Q A W P F T C L P L G V L M K G Q H L H L E T F K A V L D G
CAGGCTTGGCCTTTACATGCCTCCCCCTCGGCGTCCTGATGAAGGGACAGCATCTGCATCTGGAAACCTTTAAGGCTGTGCTCGACGGA

Gene : PRAME
Segment# : 7
Offset : 91
1st Codon : 1
G Q H L H L E T F K A V L D G L D V L L A Q E V R P R R W K
GCCCAACACTCCACTCGAGACATTCAAAGCCGTCTGGATGGCCTCGACGTCTGCTGCCCCAAGAGGTCAGGCCTAGGAGATGGAAA

Gene : PRAME
Segment# : 8
Offset : 106
1st Codon : 1
L D V L L A Q E V R P R R W K L Q V L D L R K N S H Q D F W
CTGGATGTGCTCCTGGCTCAGGAAGTGAGACCCAGAAGGTGGAAGCTCCAGGTCTGGATCTGAGAAAGAATAGCCATCAGGATTTCTGG

Gene : PRAME
Segment# : 9
Offset : 121
1st Codon : 1
L Q V L D L R K N S H Q D F W T V W S G N R A S L Y S F P P E
CTGCAAGTGCTCGACCTCAGGAAAACTCCACCAAGACTTTTGGACAGTGTGGAGCGGAAAAGAGCCTCCCTGTATAGCTTTCCCGAA

Gene : PRAME
Segment# : 10
Offset : 136
1st Codon : 1
T V W S G N R A S L Y S F P P E P E A A Q P M T K K R K V D G
ACCGTCTGGTCCGCAATAGGGCTAGCCTCTACTCCTTCCCTGAGCCTGAGGCTGCCCAACCCATGACCAAAAAGAGAAAGGTGACGGA

Gene : PRAME
Segment# : 11
Offset : 151
1st Codon : 1
P E A A Q P M T K K R K V D G L S T R A E Q P F I P V E V L
CCCGAAGCGCTCAGCCTATGACAAAGAAAAGGAAGTGGATGGCCTCAGCACAGAGGCTGAGCAACCTTTATCCCTGTGGAAGTGCTC

Gene : PRAME
Segment# : 12
Offset : 166
1st Codon : 1
L S T E A E Q P F I P V E V L V D L F L K E G A C D E L P S
CTGTCCACCGAAGCCGAAACAGCCTTTTCATTCCTGCGAGGTCTGGTGCACCTCTTCTCAAGGAAGGCGCTTGCGATCAGCTCTTCTCC

Gene : PRAME
Segment# : 13
Offset : 181
1st Codon : 1
V D L F L K E G A C D E L P S Y L I E K V K R K K N V L R L
GTGGATCTGTTTCTGAAGAGGGAGCCTGTGACGAACTGTTTAGCTATCTGATTGAGAAAGTGAAGGAAAAAGAAATGTGCTCAGGCTC

Gene : PRAME
Segment# : 14

Figure 27 (Cont)

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Offset : 196
1st Codon : 1
Y L I E K V K R K K N V L R L C C K K L K I F A M P M Q D I
TACCTCATCGAAAGGTCAAGAGAAAGAAAAACGTCTGAGACTGTGTTGCAAAAAGCTCAAGATTTTCGCTATGCCTATGCAAGACATT

Gene : PRAME
Segment# : 15
Offset : 211
1st Codon : 1
C C K K L K I F A M P M Q D I K M I L K M V Q L D S I E D L
TGCTGTAAGAAACTGAAATCTTTGCCATGCCATGCAGGATATCAAAATGATTCTGAAAATGGTCCAGCTCGACTCCATCGAAGACCTC

Gene : PRAME
Segment# : 16
Offset : 226
1st Codon : 1
K M I L K M V Q L D S I E D L E V T C T W K L P T L A K F S
AAGATGATCCTCAAGATGGTGCACTGGATAGCATTGAGGATCTGGAAGTGACATGCACATGGAAACTGCCTACCTCGCCAAATTCCTCC

Gene : PRAME
Segment# : 17
Offset : 241
1st Codon : 1
E V T C T W K L P T L A K F S P Y L G Q M I N L R R L L L S
GAGGTCACCTGTACCTGGAAGCTCCCCACACTGGCTAAGTTTAGCCCTTACCTCGCCAAATGATTAACTCAGGAGACTGCTCCTGTCC

Gene : PRAME
Segment# : 18
Offset : 256
1st Codon : 1
P Y L G Q M I N L R R L L L S H I H A S S Y I S P E K E E Q
CCCTATCTGGGACAGATGATCAATCTGAGAAGGCTCTGCTCAGCCATATCCATGCCTCCAGCTATATCTCCCCGAAAAGGAAGAGCAA

Gene : PRAME
Segment# : 19
Offset : 271
1st Codon : 1
H I H A S S Y I S P E K E E Q Y I A Q P T S Q F L S L Q C L
CACATTACGCTAGCTCTTACATTAGCCCTGAGAAGAGGAACAGTATATCGCTCAGTTTACCTCCAGTTTCTGTCCCTGCAATGCCTC

Gene : PRAME
Segment# : 20
Offset : 286
1st Codon : 1
Y I A Q P T S Q F L S L Q C L Q A L Y V D S L P F L R G R L
TACATTGCCCAATTCAGAAGCAATTCCTCAGGCTCCAGTGCTGCAAGCCCTCTAGCTCGACTCCCTGTTTCTCTCAGGGGAAGGCTC

Gene : PRAME
Segment# : 21
Offset : 301
1st Codon : 1
Q A L Y V D S L P F L R G R L D Q L L R H V M N P L E T L S
CAGGCTCTGTATGTGGATAGCCTCTTCTTTCTGAGAGGCAGACTGGATCAGCTCCTGAGACACGTCATGAATCCCTCGAGACACTGTCC

Gene : PRAME
Segment# : 22
Offset : 316
1st Codon : 1
D Q L L R H V M N P L E T L S I T N C R L S E G D V M H L S
GACCAACTGCTCAGGCATGTGATGAACCTCTGGAACCTCAGCATTACCAATTGCAGACTGTCCGAGGGAGAGCTCATGCATCTGTCC

Gene : PRAME
Segment# : 23
Offset : 331
1st Codon : 1
I T N C R L S E G D V M H L S Q S P S V S Q L S V L S L S G
ATCAGAACTGTAGGCTCAGGGAAGGCGATGTGATGCACCTCAGCCAAAGCCCTAGCGTCAGCCAACGTGTCGGTCTCAGCCTCAGCGGA

Gene : PRAME
Segment# : 24
Offset : 346
1st Codon : 1

Figure 27 (Cont)

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Q S P S V S Q L S V L S L S G V M L T D V S P E P L Q A L L
CAGTCCCTCCGTGTGCCAGCTCAGCGTCTGTCCCTGTCCGGCGTCATGCTCACCGATGTGTCCCGAACCCTCCAGGCTCTGTCTC

Gene : PRAME
Segment# : 25
Offset : 361
1st Codon : 1

V M L T D V S P E P L Q A L L E R A S A T L Q D L V F D E C
GTGATGCTGACAGAGCTCAGCCCTGAGCCTCTGCAAGCCCTCTGGAAAGGGCTAGCGCTACCTCCAGGATCTGGTCTTCGATGAGTGT

Gene : PRAME
Segment# : 26
Offset : 376
1st Codon : 1

E R A S A T L Q D L V F D E C G I T D D Q L L A L L P S L S
GAGAGAGCTCCGCCACTGCAAGACCTCGTGTGACGAATGGGAATCACAGACGATCAGCTCTGGCTCTGCTCCCTCCCTGTCTC

Gene : PRAME
Segment# : 27
Offset : 391
1st Codon : 1

G I T D D Q L L A L L P S L S H C S Q L T T L S F Y G N S I
GGCATTACCGATGACCACTGCTCGCCCTCTGCCTAGCCCTCAGCCATGTGCTCCAGCTCACCACACTGTCTCTATGGCAATAGCATT

Gene : PRAME
Segment# : 28
Offset : 406
1st Codon : 1

H C S Q L T T L S F Y G N S I S I S A L Q S L L Q H L I G L
CACTGTAGCCAACTGACAACCTCAGCTTTTACGGAACTCCATCTCCATCTCCGCCCTCCAGTCCCTGCTCCAGCATCTGATTGGCCTC

Gene : PRAME
Segment# : 29
Offset : 421
1st Codon : 1

S I S A L Q S L L Q H L I G L S N L T H V L Y P V P L E S Y
AGCATTAGCGCTCTGCAAGCTCTGCAACACCTCATCGACTGTCCAACCTCACCATGTGCTCTACCTGTGCTCTGGAAAGCTAT

Gene : PRAME
Segment# : 30
Offset : 436
1st Codon : 1

S N L T H V L Y P V P L E S Y E D I H G T L H L E R L A Y L
AGCAATCTGACACAGTCTGTATCCCGTCCCGCTCGAGTCTACGAAGACATTACGGAAACCTCCACCTCGAGAGACTGGCTTACCTC

Gene : PRAME
Segment# : 31
Offset : 451
1st Codon : 1

E D I H G T L H L E R L A Y L H A R L R E L L C E L G R P S
GAGGATATCCATGGCACACTGCATCTGGAAGGCTCGCCTATCTGCATGCCAGACTGAGAGAGCTCTGTGTGAGCTCGGCAGACCCTCC

Gene : PRAME
Segment# : 32
Offset : 466
1st Codon : 1

H A R L R E L L C E L G R P S M V W L S A N P C P H C G D R
CAGCTTAGGCTCAGGAACTGCTCTGGAACTGGGAAGGCTAGCATGGTGTGGCTGTCCGCCAATCCCTGTCCCCATTGGGAGACAGA

Gene : PRAME
Segment# : 33
Offset : 481
1st Codon : 1

M V W L S A N P C P H C G D R T F Y D P E P I L C P C F M P
ATGGTCTGGCTCAGCGCTAACCTTGGCCCTCACTGTGGCGATAGGACATTCTATGACCCTGAGCCTATCTCTGCCCTTGCTTTATGCTT

Gene : PRAME
Segment# : 34
Offset : 496
1st Codon : 1

T F Y D P E P I L C P C F M P N A A
ACCTTTTACGATCCGAACCAATTCTGTGTCCCTGTTTCATGCCCAATGCCGCT

Figure 27 (Cont)

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Gene : TRP2IN2
Segment# : 1
Offset : 1
1st Codon : 1
A A L M E T H L S S K R Y T E E A G G F F P W L K V Y Y Y R
GCCGCTCTGATGGAGACACCTCAGCTCCAAGAGATACACAGAGGAAGCCGGAGGCTTTTCCCTTGGCTCAAGGTCTACTATTACAGA

Gene : TRP2IN2
Segment# : 2
Offset : 16
1st Codon : 1
E A G G F F P W L K V Y Y Y R F V I G L R V W Q W E V I S C
GAGGCTGGCGGATTCTTTCCTGGCTGAAAGTGTATTACTATAGGTTTGTGATTGGCCTCAGGGTCTGGCAATGGGAAGTGATTAGCTGT

Gene : TRP2IN2
Segment# : 3
Offset : 31
1st Codon : 1
F V I G L R V W Q W E V I S C K L I K R A T T R Q P A A
TTCGTCATCGGACTGAGAGTGTGGCAGTGGGAGGTCTCTCTGCAAACCTGATTAGAGAGCCACAACCAGACAGCCTGCCGCT

Gene : NYNS01a
Segment# : 1
Offset : 1
1st Codon : 1
A A M Q A E G R G T G G S T G D A D G P G G P G I P D G P G
GCCGCTATGCAAGCCGAAGGCAGAGGCACAGGCCGAAGCACAGGCGATGCCGATGGCCCTGGCGGACCCGGAATCCCTGAACGGACCCGGA

Gene : NYNS01a
Segment# : 2
Offset : 16
1st Codon : 1
D A D G P G G P G I P D G P G G N A G G P G E A G A T G G R
GACGCTGACGGACCCCGAGGCCCTGGCATTCCTGATGGCCCTGGCGGAAACGCTGGCGGACCCGGAGAGGCTGGCGCTACCGGAGGCAGA

Gene : NYNS01a
Segment# : 3
Offset : 31
1st Codon : 1
G N A G G P G E A G A T G G R G P R G A G A A R A S G P G G
GGCAATGCCGGAGGCCCTCGCGAAGCCGGAGCCACAGGCCGAAGGGGACCCAGAGGCGCTGGCGCTGCCAGAGCCTCCGGCCCTGGCGGA

Gene : NYNS01a
Segment# : 4
Offset : 46
1st Codon : 1
G P R G A G A A R A S G P G G G A P R G P H G G A A S G L N
GGCCCTAGGGGAGCCCGAGCCGCTAGGGCTAGCGGACCCGGAGGCGGAGCCCTAGGGGACCCATGGCGGAGCCGCTAGCGGACTGAAT

Gene : NYNS01a
Segment# : 5
Offset : 61
1st Codon : 1
G A P R G P H G G A A S G L N G C C R C G A R G P E S R L L
GGCGCTCCAGAGGCCCTCACGGAGGCGCTGCCCTCCGGCCTCAACGGATGCTGTAGGTGTGGCGCTAGGGGACCCGAAGCAGACTGCTC

Gene : NYNS01a
Segment# : 6
Offset : 76
1st Codon : 1
G C C R C G A R G P E S R L L E F Y L A M P P A T P M E A E
GGCTGTTGAGATGCGGAGCCAGAGGCCCTGAGTCCAGGCTCCTGGAAITCTATCTGGCTATGCCCTTTCGCTACCCCTATGGAAGCCGAA

Gene : NYNS01a
Segment# : 7
Offset : 91
1st Codon : 1
E F Y L A M P P A T P M E A E L A R R S L A Q D A P P L P V
GAGTTTTACCTGCCATGCCCTTTGCCACACCCATGGAGGCTGAGCTCGCCAGAGGTCCCTGGCTCAGGATGCCCTCCCTCCCTCCCGTC

Gene : NYNS01a

Figure 27 (Cont)

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Segment# : 8
Offset : 106
1st Codon : 1
L A R R S L A Q D A P P L P V P G V L L K E F T V S G N I L
CTGGCTAGGAGAAGCCTCGCCCAAGACGCTCCCCCTCTGCCTGTGCCTGGCGTCTCAAGGAATTCACAGTGTGGGCAATATCCTC

Gene : NYNS01a
Segment# : 9
Offset : 121
1st Codon : 1
P G V L L K E F T V S G N I L T I R L T A A D H R Q L Q L S
CCCGAGTGTCTCTGAAAGAGTTTACCGTCAGCGGAAACATTCTGACAAATCAGACTGACAGCGCGTGACCATAGGCCAACTGCAACTGTCTC

Gene : NYNS01a
Segment# : 10
Offset : 136
1st Codon : 1
T I R L T A A D H R Q L Q L S I S S C L Q Q L S L L M W I T
ACCATTAGGCTCACCCTGCGGATCAGACAGCTCCAGCTCAGCATTAGCTCCTGCCCTCCAGCAACTGTCCCTGCTCATGTGGATCACA

Gene : NYNS01a
Segment# : 11
Offset : 151
1st Codon : 1
I S S C L Q Q L S L L M W I T Q C F L P V F L A Q P P S G Q
ATCTCCAGTGTCTGCAAGAGCTCAGCCTCCTGATGTGGATTACCAATGCTTTCTGCTGTGTTTCTGGCTCAGCCTCCCTCCGGCCAA

Gene : NYNS01a
Segment# : 12
Offset : 166
1st Codon : 1
Q C F L P V F L A Q P P S G Q R R A A
CAGTGTTCCTCCCGCTCTTCCTCGCCCAACCCCTAGCGGACAGAGAAGGGCTGCC

Gene : NYNS01b
Segment# : 1
Offset : 1
1st Codon : 1
A A M L M A Q E A L A P L M A Q G A M L A A Q E R R V P R A
GCCGCTATGCTCATGGCTCAGGAAGCCCTCGCCTTCTGATGGCCCAAGCGCTATGCTCGCCGCTCAGGAAAGGAGAGTGCTTAGGGCT

Gene : NYNS01b
Segment# : 2
Offset : 16
1st Codon : 1
Q G A M L A A Q E R R V P R A A E V P G A Q G Q Q G P R G R
CAGGAGCCATGCTGGCTGCCCCAAGAGAGAAGGGTCCCCAGAGCCGCTGAGGTCCCGGAGCCCAAGGCCAACAGGGACCCAGAGGCAGA

Gene : NYNS01b
Segment# : 3
Offset : 31
1st Codon : 1
A E V P G A Q G Q Q G P R G R E E A P R G V R M A A R L Q G
GCCGAGTGCCTGGCGCTCAGGGAAGCAAGGCCCTAGGGGAAGGGAAGAGGCTCCAGAGGGGTCAAGATGGCCGCTAGGGCTCCAGGGA

Gene : NYNS01b
Segment# : 4
Offset : 46
1st Codon : 1
E E A P R G V R M A A R L Q G A A
GAGGAAGCCCTAGGGGAGTGAGAATGGCTGCCAGACTGCAAGGCCGCTGCC

Gene : LAGE1
Segment# : 1
Offset : 1
1st Codon : 1
A A M Q A E G Q G T G G S T G D A D G P G G P G I P D G P G
CCGCTATGCAAGCCGAAGGCCAAGGCACAGGCCGAAGCAAGGCCGATGCCGATGGCCCTGGCGGACCCGGAATCCCTGACGGACCCGGA

Gene : LAGE1
Segment# : 2
Offset : 16

Figure 27 (Cont)

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1st Codon : 1
D A D P G G P G I P D G P G G N A G G P G E A G A T G G R
G A C C T G A C G G A C C C G A G G C C C T G G C A T T C C G A T G G C C T G G C G G A A C G T G G C G G A C C C G A G A G G C T G G C G T A C C G G A G G C A G A

Gene : LAGE1
Segment# : 3
Offset : 31
1st Codon : 1
G N A G G P G E A G A T G G R G P R G A G A A R A S G P R G
G C A A T G C C G G A G G C C C T G G C G A A G C G G A G C C A C A G G C G G A A G G G A C C C A G A G G C G T G G C G C T G C C A G A G C C T C C G G C C C T A G G G G A

Gene : LAGE1
Segment# : 4
Offset : 46
1st Codon : 1
G P R G A G A A R A S G P R G G A P R G P H G G A A S A Q D
G C C C T A G G G G A C C G G A G C C G T A G G G T A G C G A C C A G A G G C G G A G C C C T A G G G A C C C A T G G C G G A G C C G T A G C G C T C A G G A T

Gene : LAGE1
Segment# : 5
Offset : 61
1st Codon : 1
G A P R G P H G G A A S A Q D G R C P C G A R R P D S R L L
G C G C T C C C A G A G G C C C T C A C G A G G C G C T C C C T C C G C C A A G A G C G A A G G T G T C C C T G T G G C G C T A G G A G A C C G A T A G C A G A C T G C T C

Gene : LAGE1
Segment# : 6
Offset : 76
1st Codon : 1
G R C P C G A R R P D S R L L Q L H I T M P F S S P M E A E
G G C A T G C C C T T G C G G A G C C A G A A G G C C T G A C T C C A G G C T C C T G C A A C T G C A T A C A A T G C C T T T C T C A G C C C T A T G G A A G C C G A A

Gene : LAGE1
Segment# : 7
Offset : 91
1st Codon : 1
Q L H I T M P F S S P M E A E L V R R I L S R D A A P L P R
C A G T C C A T T A C C A T G C C C T T T A G C T C C C C A T G G A G G C T G A G C T C G T G A G A A G A T T C T G T C C A G G A T G C C G C T C C C C T C C C C A G A

Gene : LAGE1
Segment# : 8
Offset : 106
1st Codon : 1
L V R R I L S R D A A P L P R P G A V L K D F T V S G N L L
C T G T C A G G A A T C C T C A G C A G A C G C T G C C C C T C T G C C T A G G C C T G G C G C T G T G C T C A A G G A T T C A C A G T G T C C G G C A A T C T G C T C

Gene : LAGE1
Segment# : 9
Offset : 121
1st Codon : 1
P G A V L K D F T V S G N L L F I R L T A A D H R Q L Q L S
C C C G A G C C G T C T G A A G A C T T T A C C G T C A G C G A A A C C T C C T G T T A T C A G A C T G A C A G C C G C T G A C C A T A G G C A A C T G C A A C T G T C C

Gene : LAGE1
Segment# : 10
Offset : 136
1st Codon : 1
F I R L T A A D H R Q L Q L S I S S C V Q L S L L M W I T
T T C A T T A G G C T A C C G C T G C G A T C A C A G A C A G C T C C A G C T C A G C A T T A G C T C C T G C C T C C A G C A A C T G T C C C T G C T C A T G T G G A T C A C A

Gene : LAGE1
Segment# : 11
Offset : 151
1st Codon : 1
I S S C L Q Q L S L L M W I T Q C F L P V F L A Q A P S G Q
A T C T C A G C T G T C T G C A A C A G C T C A G C C T C C T G A T G T G G A T T A C C C A A T G C T T T C T G C C T G T G T T T C T G G C T C A G G C T C C C T C C G G C C A A

Gene : LAGE1
Segment# : 12
Offset : 166
1st Codon : 1
Q C F L P V F L A Q A P S G Q R R A A

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CAGTGTTCCTCCCGTCTTCTCGCCCAAGCCCTAGCGGACAGAGAAGGGCTGCC

Segments in scrambled order:

MAGE-1 #15A P E E E I W E E L S V M E V Y D G R E H S A Y G E P R K L
CCCCCTGAGGAAGAGATTGGGAAGAGCTCAGCGTCATGGAAGTGTATGACGGAAGGGAACACTCCGCCTATGCCGAACCCAGAAAGCTC

MAGE-1 #4

E E V P T A G S T D P P Q S P Q G A S A F P T T I N F T R Q
GAGGAAGTGCTACCGCTGGCTCCACCGATCCCCCTCAGTCCCCCAAGGCGCTAGCGCTTCCCTACCACAATCAATTTCAAGGCAA

PRAME #10

T V W S G N R A S L Y S P P E P E A A Q P M T K K R K V D G
ACCGTCTGGTCCGGCAATAGGGCTAGCCTCTACTCCTTCCTGAGCGCTGAGGCTGCCCAACCCATGACCAAAAAGAGAAAGGTCGACGGA

MAGE-3 #14

Q I M P K A G L L I I V L A I I A R E G D C A P E E K I W E
CAGATTATGCCTAAGGCTGGCTCCTGATTATCGTCTGGCTATCATTGCCAGAGAGGAGACTGTGCCCTGAGGAAAAGATTGGGAA

PRAME #9

L Q V L D L R K N S H Q D F W T V W S G N R A S L Y S P P E
CTGCAAGTCTCGACCTCAGGAAAACTCCCAACAGACTTTTGGACAGTGTGGAGCGGAAACAGAGCCTCCCTGTATAGCTTTCCCGAA

PRAME #8

L D V L L A Q E V R P R R W K L Q V L D L R K N S H Q D F W
CTGGATGTGCTCCTGGCTCAGGAAGTGAGACCCAGAAGGTGGAAGCTCCAGGTCTTGGATCTGAGAAAGAATAGCCATCAGGATTCTCG

NYNS01b #2

Q G A M L A A Q E R R V P R A A E V P G A Q G Q Q G P R G R
CAGGGAGCATGCTGGCTGCCAAGAGAGAAGGCTCCCAAGAGCGCTGAGGTCCCCGAGCCCAAGGCCAACAGGGACCCAGAGGCCAGA

PRAME #24

Q S P S V S Q L S V L S L S G V M L T D V S P E P L Q A L L
CAGTCCCCCTCCGTGTCCAGCTCAGCGTCTGTCTGTCCGTGTCCGCGTCATGCTCACCGATGTGTCCCCGAACCCCTCCAGGCTCTGTCTC

MAGE-1 #17

L T Q D L V Q E K Y L E Y R Q V P D S D P A R Y E F L W G P
CTGACACAGGATCTGGTCCAGGAAAAGTATCTGGAATACAGACAGGTCCCCGATAGCGATCCCGCTAGGTATGAGTTTCTGTGGGGCCCT

MAGE-1 #6

R Q P S E G S S S R E E E G P S T S C I L E S L F R A V I T
AGGCAACCTCCGAGGGAAGCTCCAGCAGAGAGGAAGGGACCTCCACCTCCTGCATTCTGGAAAGCCTCTTCAGAGCCGTCATCACA

BAGE #1

A A M A A R A V F L A L S A Q L L Q A R L M K E E S P V V S
CCCGCTATGGCTGCCAGAGCCGCTCTTCTCGCCCTCAGCGCTCAGCTCCTGCAAGCCAGACTGATGAAGGAAGAGTCCCCCGTGTGTCTC

PRAME #34

T F Y D P E P I L C P C F M P N A A
ACCTTTACGATCCCGAACCCATTCTGTGTCCCTGTTTCATGCCCAATGCCGCT

MAGE-3 #12

I E L M E V D P I G H L Y I F A T C L G L S Y D G L L G D N
ATCGAATGATGGAGGTGACCCCTATCGGACACCTCTACATTTTCGCTACCTGTCTGGGACTGTCTACGATGGCCTCCTGGGAGACAAT

CAGE-1 #2

R R Y V E P P E M I G P M R P E Q F S D E V E P A T P E E G
AGGAGATACGTGAGCCTCCCGAAATGATTGGCCCTATGAGACCCGAACAGTTTAGCGATGAGGTGAGCCTGCCACACCCGAAGAGGGA

TRP21N2 #2

E A G G F F P W L K V Y Y Y R F V I G L R V W Q W E V I S C
GAGGCTGGCGGATCTTTCCCTGGCTGAAAGTGTATTACTATAGGTTTGTGATTGGCCTCAGGGTCTGGCAATGGGAAGTGATTAGCTGT

PRAME #1

A A M E R R R L W G S I Q S R Y I S M S V N T S P R R L V E
CCCGCTATGGAAGGAGAAGGCTCTGGGGAAGCATTAGTCCAGGTATATCTCCATGTCCGTGTGGACCTCCCCAGAGGCTCGTGGAA

TRP21N2 #1

A A L M E T H L S S K R Y T E E A G G P F P W L K V Y Y Y R
CCGCTCTGATGGAGACACCTCAGCTCCAAGAGATACAGAGGAAGCCGAGGCTTTTCCCTTGGCTCAGGTCTACTATTACAGA

Figure 27 (Cont)

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MAGE-1 #1

A A M S L E Q R S L H C K P E E A L E A Q Q E A L G L V C V
GCCGCTATGTCCCTGGAAACAGAGAAGCCTCCACTGTAAGCCTGAGGAAGCCCTCGAGGCTCAGCAAGAGGCTCTGGGACTGGTCTGCGTC

MAGE-1 #3

Q A A T S S S S P L V L G T L E E V P T A G S T D P P Q S P
CAGGCTGCCAAGCTCCAGCTCCCCCTCGTGCTCGGCACACTGGAAGAGGTCCCCACAGCCGGAAGCACAGACCCTCCCCAAAGCCCTC

PRAME #4

A L E L L P R E L P P P L P M A A P D G R H S Q T L K A M V
GCCCTCGAGCTCCTGCTAGGGAAGCTGTTCCCTCTGTGTTATGGCTGCTTTGACGGAAGGCATAGCCAAACCTCAAGGCTATGGTC

MAGE-3 #16

E L S V L E V P E G R E D S I L G D P K K L L T Q H F V Q E
GAGCTCAGCGTCTCGAAGTGTGTTAGGGAAGGGAAGACTCCATCCTCGCGATCCCAAAAGCTCCTGACACAGCATTTCTGTCAGGAA

MAGE-1 #11

E S L Q L V F G I D V K E A D P T G H S Y V L V T C L G L S
GAGTCCCTGCAACTGGTCTTCGGAATCGATGTGAAGAGGCTGACCTACCGACACTCCTACGTCTGGTCACCTGTCTGGGACTGTCC

MAGE-3 #5

P D P P Q S P Q G A S S L P T T M N Y P L W S Q S Y E D S S
CCCGATCCCCCTCAGTCCCCCAAGGCGTAGCTCCCTGCCTACCAATGAATTACCTCTGTGGAGCCAAAGCTATAGGATAGCTCC

LAGE1 #1

A A M Q A E G Q G T G G S T G D A D G P G G P G I P D G P G
GCCGCTATGCAAGCCGAAGGCCAAGGCACAGGCAGGAGCAAGGCGATGCCGATGCCCTGGCGGACCCGGAATCCCTGACGGACCCGGA

NYNS01a #12

Q C F L P V F L A Q P P S G Q R R A A
CAGTGTTCCTCCCGTCTTCTCGCCCAACCCCTAGCGGACAGAGAAGGGCTGCC

gp100In4 #2

T W G E G L P S Q P I I H T C V Y F F L P D H L S F G R P P
ACCTGGGCGAAGGCTCCCTCCCGCTATCATTACACATGCGTCTACTTTTCTCTCCCGATCAGCTCAGCTTTGGCAGACCTTT

MAGE-1 #7

S T S C I L E S L P R A V I T K K V A D L V G F L L L K Y R
AGCAAGCTGTATCTCGAGTCCCTGTTTAGGGCTGTGATTACCAAAAGGTGCGCGATCTGGTCCGCTTTCTGCTCCTGAAATACAGA

NYNS01a #1

A A M Q A E G R G T G G S T G D A D G P G G P G I P D G P G
GCCGCTATGCAAGCCGAAGGCAGAGGCACAGGCGGAAGCACAGGCGATGCCGATGGCCCTGGCGGACCCGGAATCCCTGACGGACCCGGA

CAGE-1 #7

D G P D G Q E M D P P N P E E V K T P E E E M R S H Y V A Q
GACGGACCCGATGCCAAGAGATGGACCTCCCAATCCCGAAGAGGTCAAGACACCCGAAGAGGAATGAGAAGCCATTACGTGCCCAA

NYNS01a #11

I S S C L Q Q L S L L M W I T Q C F L P V F L A Q P P S G Q
ATCTCCAGCTGTCTGCAACAGCTCAGCCTCCTGATGTGGATTACCAATGCTTTCTGCTGTGTTCTGGCTCAGCCTCCCTCCGCCCCA

PRAME #26

E R A S A T L Q D L V F D E C G I T D D Q L A L L P S L S
GAGAGAGCCTCCGCCACACTGCAAGACCTCGTGTGACGAATGCGGAATCACAGACGATCAGCTCCTGGCTCTGCTCCCTCCCTGTCC

MAGE-3 #17

L G D P K K L L T Q H F V Q E N Y L E Y R Q V P G S D P A C
CTGGGAGACCTAAGAACTGCTCAGCCCAACACTTTGTGCAAGAGAATTACCTCGAGTATAGGCAAGTGCTGCTCGCTCCGACCTGCTGT

MAGE-1 #2

E A L E A Q Q E A L G L V C V Q A A T S S S S P L V L G T L
GAGGCTCTGGAAGCCCAACAGGAAGCCCTCGGCTCGTGTGTGCAAGCCGCTACCTCCAGCTCCAGCCCTCTGGTCTGGGAACCTTC

NYNS01a #7

E F Y L A M P F A T P M E A E L A R R S L A Q D A P P L P V
GAGTTTTACCTCGCCATGCCCTTTGCCACACCATGGAGGCTGAGCTCGCCAGAAGGTCCCTGGCTCAGGATGCCCTCCCTCCCTCCCTC

NYNS01b #4

E E A P R G V R M A A R L Q G A A
GAGGAAGCCCTAGGGGAGTGAGAATGGCTGCCAGACTGCAAGGCGCTGCC

Figure 27 (Cont)

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BAGE #3

W R L E P E D G T A L C F I F A A
TGGAGACTGGAACCGAAGACGGAACCGCTCTGTGTTTCATTTTCGCTGCC

GAGE-1 #3

E Q F S D E V E P A T P E E G E P A T Q R Q D P A A A Q E G
GAGCAATTCTCCGACGAAGTGGAAACCGCTACCCCTGAGGAAGGCGAACCGCTACCCAAAGGCAAGACCTGCGCTGCCAAGAGGGA

MAGE-3 #6

T M N Y P L N S Q S Y E D S S N Q E E E G P S T F P D L E S
ACCATGAACACTACCCCTCTGGTCCAGTCTACGAAGACTCCAGCAATCAGGAAGAGGAAGGCCCTAGCACATTCCCTGACCTCGAGTCC

MAGE-3 #7

N Q E E E G P S T F P D L E S E F Q A A L S R K V A E L V H
AACCAGAGGAAGAGGGACCTCCACCTTTCCCGATCTGGAAGCGAATTCCAGCGCTCTGTCCAGGAAGTGGCTGAGCTCGTGCT

PRAME #13

V D L F L K E G A C D E L F S Y L I E K V K R K K N V L R L
GTGGATCTGTTTCTGAAAGAGGGAGCCTGTGACGAACGTGTTAGCTATCTGATTGAGAAAGTGAAGGAAAAAGAAATGTGCTCAGGCTC

NYNS01a #10

T I R L T A A D H R Q L Q L S I S S C L Q Q L S L L M W I T
ACCATTAGGCTCACCGCTGCCGATCAGACAGCTCCAGCTCAGCATTAGCTCCTGCCTCCAGCAACTGTCCCTGCTCATGTGGATCACA

MAGE-3 #1

A A M P L E Q R S Q H C K P E E G L E A R G E A L G L V G A
GCGCTATGCTCTGGAACAGAGAAGCCAACACTGTAAGCCTGAGGAAGCGCTCGAGGCTAGGGGAGAGGCTCTGGGACTGGTGGCGCT

NYNS01a #2

D A D G P G G P G I P D G P G G N A G G P G E A G A T G G R
GAGCTGACGGACCCGAGGCCCTGGCATTCCCGATGGCCCTGGCGGAACCGCTGGCGGACCCGAGAGGCTGGCGCTACCGGAGGCAGA

MAGE-3 #19

Y E F L W G P R A L V E T S Y V K V L H H M V K I S G G P H
TAGCAATTCTCTGGGAGCCAGAGCCCTGTGGAACCTCTACGTCAAGGTCTGCATCAGTGGTGAATACTCCGGCGGACCCCAT

PRAME #23

I T N C R L S E G D V M H L S Q S P S V S Q L S V L S L S G
ATCAGAACTGTAGGCTCAGCGAAGGCGATGTGATGCACTCAGCCAAAGCCCTAGCGTCAGCCAACTGTCCGTGCTCAGCCTCAGCGGA

MAGE-3 #18

N Y L E Y R Q V P G S D P A C Y E F L W G P R A L V E T S Y
AACTATCTGGAATACAGACAGGTCCCGGAAGCGATCCCGCTTGCTATGAGTTTCTGTGGGGCCCTAGGGCTCTGGTCGAGACAAGCTAT

MAGE-3 #11

V I F S K A S S S L Q L V F G I E L M E V D P I G H L Y I P
GTGATTTCTCCAGGCTAGCTCCAGCCTCCAGCTCGTGTGTCGCAAGCCCTCTACGTGCACTCCCTGTTTCTCAGGGGAAGGCTC

PRAME #21

Q A L Y V D S L F F L R G R L D Q L L R H V M N P L E T L S
CAGGCTCTGTATGTGGATAGCCTCTTCTTTCTGAGAGGCAGACTGGATCAGCTCCTGAGACAGTCATGAATCCCTCGAGACACTGTCC

PRAME #20

Y I A Q F T S Q F L S L Q C L Q A L Y V D S L F F L R G R L
TACATTGCCCAATTCAGAAGCCAATTCTCAGCCTCCAGTGTCTGCAAGCCCTCTACGTGCACTCCCTGTTTCTCAGGGGAAGGCTC

PRAME #7

G Q H L H L E T F K A V L D G L D V L L A Q E V R P R R W K
GGCCAACACTCCACTCGAGACATTCAAGCCGCTCTGGATGGCCTCGACGCTCTGCTCGCCCAAGAGGTCAGGCTTAGGAGATGGA

LAGE1 #10

F I R L T A A D H R Q L Q L S I S S C L Q Q L S L L M W I T
TTCATTAGGCTCACCGCTGCCGATCAGACAGCTCCAGCTCAGCATTAGCTCCTGCCTCCAGCAACTGTCCCTGCTCATGTGGATCACA

PRAME #15

C C K K L K I F A M P M Q D I K M I L K M V Q L D S I E D L
TGCTGTAAAGAAATGAAAATCTTTGCCATGCCATGCAGGATATCAAAATGATTCTGAAAATGGTCCAGCTCGACTCCATCGAAGACCTC

NYNS01a #5

G A P R G P H G G A A S G L N G C C R C G A R G P E S R L L
GGCGCTCCAGAGGCCCTCAGCGAGGCGCTGCGCTCCGGCTCAACGGATGCTGTAGGTGTGGCGCTAGGGGACCCGAAGCAGACTGTCTC

Figure 27 (Cont)

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MAGE-1 #8
K K V A D L V G F L L L K Y R A R E P V T K A E M L E S V I
AAGAAAGTGGCTGACCTCGTGGGATTCTCTGCTCAAGTATAGGGCTAGGGAAACCGTCACCAAAGCCGAAATGCTCGAGTCGGTGATT

MAGE-1 #13
Y D G L L G D N Q I M P K T G F L I I V L V M I A M E G G H
TACGATGGCCTCTGGGAGACAATCAGATTATGCCTAAGACAGGCTTTCTGATTATCGTCTGGTCATGATTGCCATGGAGGGAGGCCAT

FRAME #29
S I S A L Q S L L Q H L I G L S N L T H V L Y P V P L E S Y
AGCATTAGCGCTCTGCAAAGCCCTCTGCAACACCTCATCGGACTGTCCAACCTCACCCATGTGCTCTACCTCTGCTCTGGAAAGCTAT

MAGE-3 #15
I A R E G D C A P E E K I W E E L S V L E V F E G R E D S I
ATCGTAGGGAAGGCCATTGGCTCCCGAAGAGAAAATCTGGGAGGAATGTCCGTGCTCGAGGTCTTGAAGGCAGAGAGGATAGCATT

FRAME #22
D Q L L R H V M N P L E T L S I T N C R L S E G D V M H L S
GACCAACTGCTCAGGCATGTGATGAACCCCTCTGGAACCCCTCAGCATTACCAATTGCAGACTGTCCGAGGGAGACGTCATGCATCTGTCC

MAGE-1 #19
R A L A E T S Y V K V L E Y V I K V S A R V R F F P P S L R
AGGGCTCTGGCTGAGACAAGCTATGTGAAAGTCTCGAGTATGTGATTAAAGTCAAGCTAGGGTCAGGTTTTCTTTCCCTCCCTGAGA

FRAME #30
S N L T H V L Y P V P L E S Y E D I H G T L H L E R L A Y L
AGCAATCTGACACAGTCTGTATCCCGTCCCCCTCGAGTCTACGAAGACATTCAAGGAACCCCTCCACCTCGAGAGACTGGCTTACCTC

WYNS01b #1
A A M L M A Q E A L A F L M A Q G A M L A A Q E R R V P R A
CCGCTATGCTCATGGCTCAGGAAGCCCTCGCCTTTCTGATGGCCCAAGGCGCTATGCTCGCCGCTCAGGAAGGAGAGTGCCTAGGGCT

MAGE-1 #10
K N Y K H C F P P E I F G K A S E S L Q L V F G I D V K E A D
AAGAATTACAAACTGTTTCCCTGAGATTTTCGGAAGGCTACGGAAGCCTCCAGCTCGTGTGTTGGCATTGACGTCAGGAAGCCGAT

MAGE-3 #4
T L V E V T L G E V P A A E S P D P P Q S P Q G A S S L P T
ACCTCTGTTGGAAGTGACACTGGGAGAGGTCCCGCTGCCGAAGCCCTGACCCCTCCCAAGCCCTCAGGGAGCCTCCAGCCTCCCCACA

FRAME #32
H A R L R E L L C E L G R P S M V W L S A N P C P H C G D R
CAGCTAGGCTCAGGAACTGCTCTGGAACTGGGAAGGCTAGCATGGTGTGGCTGTCCGCCAATCCCTGTCCCCATTGCGGAGACAGA

FRAME #25
V M L T D V S P E P L Q A L L E R A S A T L Q D L V F D E C
GTGATGCTGACAGCGTCAGCCCTGAGCCTCTGCAAGCCCTCTGGAAGGGCTAGGCTACCTCCAGGATCTGGTCTTCGATGAGTGT

GAGE-1 #5
E D E G A S A G Q G P K P R A D S Q E Q G H P Q T G C E C E
GAGGATGAGGGAGCCTCCGCCGACAGGACCCAAACCGAAGCCGATAGCCAAGAGCAAGGCCATCCCAACCGGATGCGAATGCGAA

MAGE-3 #10
E M L G S V V G N W Q Y F P P V I F S K A S S S L Q L V F G
GAGATGCTGGGAAGCGTCTGGGAAACTGGCAGTATTTCTTTCCCGTCTCTTAGCAAGCCCTCCAGCTCCCTGCAACTGGTCTTCGGA

GAGE-1 #1
A A M S W R G R S T Y R P R P R R Y V E P P E M I G P M R P
GCCGCTATGTCCTGGAGAGGCAGAACCATACAGACCCAGACCCAGAAGGTATGTGGAACCCCTGAGATGATGGACCCATGAGGCCT

FRAME #2
Y I S M S V W T S P R R L V E L A G Q S L L K D E A L A I A
TACATTAGCATGAGCGTCTGACAAAGCCCTAGGAGACTGGTGGAGCTCGCCGACAGTCCCTGCTCAAGGATGAGGCTCTGGCTATCCCT

MAGE-1 #16
Y D G R E H S A Y G E P R X L L T Q D L V Q E K Y L E Y R Q
TAGATGGCAGAGCATAGGCTTACGGAGAGCCTAGGAACTGCTCACCAAGACCTCGTCCAAGAGAAATACCTCGAGTATAGGCAA

LAGE1 #12
Q C F L P V F L A Q A P S G Q R R A A
CAGTGTTCCTCCCGTCTTCTCGCCCAAGCCCTAGGGACAGAGAAGGGCTGCC

Figure 27 (Cont)

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MAGE-3 #20

V K V L H H M V K I S G G P H I S Y P P L H E W V L R E G E
GTGAAAGTGCTCCACCATATGGTCAAGATTAGCGGAGGCCCTCACATTAGCTATCCCCCTCTGCATGAGTGGGTGCTCAGGGAAGCGAA

LAGE1 #7

Q L H I T M P P S S P M E A E L V R R I L S R D A A P L P R
CAGCTCCACATTACCATGCCCTTTAGCTCCCCCATGGAGGCTGAGCTCGTGAGAAGGATTCTGTCCAGGGATGCCGCTCCCTCCCCAGA

NYNS01a #9

P G V L L K E F T V S G N I L T I R L T A A D H R Q L Q L S
CCCGAGTGCTCCTGAAAGAGTTACCGTCAGCGGAACATTCTGACAACTCAGACTGACAGCGCTGACCATAGGCAACTGCAACTGTCT

PRAME #16

K M I L K M V Q L D S I E D L E V T C T W K L P T L A K F S
AAGATGATCCTCAAGATGGTGCAACTGGATAGCATTGAGGATCTGGAAGTGACATGCACATGGAAGTGCCTACCTCGCCAAATTCTCC

MAGE-1 #14

F L I I V L V M I A M E G G H A P E E E I W E E L S V M E V
TTCTCATCATTTGCTCGTGATGATCGCTATGGAAGCGGACAGCTCCCGAAGAGGAAATCTGGGAGGAACTGTCCGTGATGGAGGTC

PRAME #17

E V T C T W K L P T L A K F S P Y L G Q M I N L R R L L L S
GAGGTCACTGTACCTGGAAGCTCCCCACACTGGCTAAGTTTAGCCCTTACCTCGGCCAAATGATTAACTCAGGAGACTGCTCCTGTCC

MAGE-3 #2

E G L E A R G E A L G L V G A Q A P A T E E Q E A A S S S S
GAGGGACTGGAAGCCAGAGGCGAAGCCCTCGGCTCGTGGGAGCCCAAGCCCTGCCACAGAGGAACAGGAAGCCGCTAGCTCCAGCTCC

MAGE-3 #21

I S Y P P L H E W V L R E G E E A A
ATCTCCTACCTCCCTCCACGAATGGGTCTGAGAGAGGGAGAGGAAGCCGCT

PRAME #19

H I H A S S Y I S P E K E E Q Y I A Q P T S Q P L S L Q C L
CACATTACGCTAGCTCCTACATTAGCCCTGAGAAAGAGGAACAGTATATCGCTCAGTTTACCTCCAGTTTCTGTCCCTGCAATGCCTC

NYNS01a #3

G N A G C P G E A G A T G G R G P R G A G A A R A S G P G G
GGCAATCCCGAGGCCCTGGGGAAGCCCGAGCCACAGCGGAAGGGGACCCAGAGGCGCTGGCGCTGCCAGAGCCTCGGCGCTGGCGGA

NYNS01a #4

G P R G A G A A R A S G P G G G A P R G P H G G A A S G L N
GGCCCTAGGGGAGCCGAGCCGCTAGGGCTAGCGGACCCGAGGCGGAGCCCTAGGGGACCCATGGCGGAGCCGCTAGCGGACTGAAT

MAGE-1 #5

Q G A S A F P T T I N F T R Q R Q P S E G S S S R E E E G P
CAGGGAGCCTCCGCTTTCCCAACCATTAACCTTTACCAGACAGAGACAGCCTAGCGAAGGCTCCAGCTCCAGGGAAGAGGAAGGCCCT

NYNS01a #8

L A R R S L A Q D A P P L P V P G V L L K E F T V S G N I L
CTGGCTAGGAGAAGCCTCGCCCAAGAGCCTCCCCCTCTGCCTGTGCCTGGCGTCTGCTCAAGGAATTCACAGTGTCCGGCAATATCCTC

PRAME #5

A A F D G R H S Q T L K A M V Q A W P F T C L P L G V L M K
GCCGCTTTCGATGGCAGACACTCCAGACACTGAAAGCCATGGTGCAAGCCTGGCCCTTTACCTGTCTGCCTCTGGGAGTGCTCATGAA

MAGE-1 #20

I K V S A R V R F F F P S L R E A A L R E E E E G V A A
ATCAAGTGTCGCCAGAGTGAGATTCTTTTCCCTAGCCTCAGGGAAGCCGCTCTGAGAGAGGAAGAGGAAGCCGCTCGCCGCT

PRAME #27

G I T D D Q L L A L L P S L S H C S Q L T T L S F Y G N S I
GGCATTACCGATGACCAACTGCTCGCCCTCCTGCCTAGCCTCAGCCATTGCTCCAGCTCACCACACTGCTCTCTATGGCAATAGCATT

MAGE-1 #8

V K T P E E E M R S H Y V A Q T G I L W L L M N N C F L N L
GTGAAACCCCTGAGGAAGAGATGAGTCCCACTATGTGGCTCAGACAGGCATTCTGTGGCTGCTCATGAATAACTGTTTCTCTCAACCTC

LAGE1 #11

I S S C L Q Q L S L L M W I T Q C F L P V F L A Q A P S G Q
ATCTCAGCTGTCTGCAACAGCTCAGCCTCCTGATGTGGAATTACCCAATGCTTTCTGCTGTGTTCTGGCTCAGGCTCCCTCGGCCAA

Figure 27 (Cont)

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FRAME #14
Y L I E K V K R K K N V L R L C C K K L K I F A M P M Q D I
TACCTCATCGAAAAGGTCAGAGAGAAAAGAAACGCTCCTGAGACTGTGTTGCAAAAAGCTCAAGATTTTCGCTATGCCTATGCAAGACATT

MAGE-1 #9
A R E P V T K A E M L E S V I K N Y K H C F P E I F G K A S
GCCAGAGAGCCTGTGACAAAGGCTGAGATGCTGGAAGCGTCATCAAAAATATAAGCATTGCTTTCCCGAAATCTTTGGCAAAGCCTCC

LAGE1 #8
L V R R I L S R D A A P L P R P G A V L K D F T V S G N L L
CTGGTCAGAGAAATCCTCAGCAGAGAGCTGCCCTCTGCCTAGGCTGGCGCTGTGCTCAAGGATTTACAGTGTCCGGCAATCTGCTC

FRAME #28
H C S Q L T T L S F Y G N S I S I S A L Q S L L Q H L I G L
CACTGTAGCCAACTGACAAACCTCAGCTTTACGGAACTCCATCTCCATCTCCGCCCTCCAGTCCCTGCTCCAGCATCTGATTGGCCTC

FRAME #33
M V W L S A N P C P H C G D R T F Y D P E P I L C P C F M P
ATGCTCTGGCTCAGCGCTAACCTTGCCTCCTGCTGCGATAGGACATTCTATGACCTGAGCCTATCTCTGCCCTTGCTTTATGCTC

gp100In4 #1
A A S W S Q K R S F V Y V W K T W G E G L P S Q P I I H T C
CCCGTAGCTGGAGCCAAAAGAGAAGCTTTGTGTATGTGTGGAAGACATGGGGAGAGGACTGCCCTAGCCAAACCCATTATCCATACCTGT

BAGE #2
L L Q A R L M K E E S P V V S W R L E P E D G T A L C P I F
CTGCTCCAGGCTAGGCTCATGAAAGAGGAAGCCCTGTGGTCAGCTGGAGGCTCCAGCTGAGGATGGCACAGCCCTCTGCTTTATCTTT

gp100In4 #3
V Y F P L P D H L S F G R P F H L N F C D P L A A
GTGTATTCTTTCTGCTGACCATCTGTCTCTCGAAGGCTTTCCATCTGAATTTCTGTGACTTTCTGGCTGCC

FRAME #18
P Y L G Q M I N L R R L L L S H I H A S S Y I S P E K E E Q
CCCTATCTGGGACAGATGATCAATCTGAGAAGGCTCCTGCTCAGCCATATCCATGCCCTCCAGCTATATCTCCCCGAAAAGGAAGAGCAA

MAGE-3 #3
Q A P A T E E Q E A A S S S S T L V E V T L G E V P A A E S
CAGGCTCCCGCTACCGAAGAGCAAGAGGCTGCCTCCAGCTCCAGCACACTGGTCGAGGTACCCCTCGGCGAAGTGCTGCGCTGAGTCC

FRAME #6
Q A W P F T C L P L G V L M K G Q H L H L E T F K A V L D G
CAGGCTTGGCTTTACATGCTCCCCCTGGCGCTCTGATGAAGGACAGCATCTGCATCTGGAACCTTTAAGGCTGTGCTCGACCGA

FRAME #12
L S T E A E Q P F I P V E V L V D L F L K E G A C D E L F S
CTGTCCACCGAAGCGCAAGAGCCTTTTCATTCCTGCGAGGTCTGCTGACCTCTTCTCAAGGAAGCGCTTGCATGAGCTCTTCTCC

NYNS01b #3
A E V P G A Q G Q Q G P R G R E E A P R G V R M A A R L Q G
GCCAAGTGCTGGCGCTCAGGGACAGCAAGCCCTAGGGGAAGGGAAGGCTCCAGAGGCGTCAAGATGGCGCTAGGCTCCAGGGA

LAGE1 #5
G A P R G P H G G A A S A Q D G R C P C G A R R P D S R L L
GGCGCTCCAGAGGCCCTCAGGAGGCGCTGCTCCGCCCAAGACGGAAGGTGTCCCTGTGGCGCTAGGAGACCGATAGCAGACTGCTC

LAGE1 #4
G P R G A G A A R A S G P R G G A P R G P H G G A A S A Q D
GGCCTAGGGGAGCCGAGCGCTAGGCTAGCGGACCCAGAGGCGGAGCCCTAGGGGACCCATGGCGGAGCCGCTAGCGCTCAGGAT

FRAME #3
L A G Q S L L K D E A L A I A A L E L L P R E L F P P L F M
CTGGCTGGCCAAAGCCTCTGAAAGACGAAGCCCTCGCCATTGCGGCTCTGGAACTGCTCCCGAGAGAGCTCTTCCCTCCCTCTTCTATG

GAGE-1 #4
E P A T Q R Q D P A A A Q E G E D E G A S A G Q G P K P E A
GAGCCTGCCACACAGACAGGATCCCGCTCCGCTCAGGAAGGCGAAGACGAAGGCGCTAGCGCTGGCCAAGGCCCTAAGCCTGAGGCT

FRAME #11
P E A A Q P M T K K R K V D G L S T E A E Q P F I P V E V L
CCCGAAGCGCTCAGCCTATGACAAAGAAAAGGAAGTGGATGGCTCAGCACAGAGGCTGAGCAACCTTTATCCCTGTGGAAGTGCTC

Figure 27 (Cont)

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LAGE1 #6

G R C P C G A R R P D S R L L Q L H I T M P F S S P M E A E
GGCAGATGCCCTTGGGAGCCAGAGGCTGACTCCAGGCTCCTGCAACTGCATATCACAATGCCTTTCTCCAGCCCTATGGAAGCCGAA

LAGE1 #9

P G A V L K D F T V S G N L L F I R L T A A D H R Q L Q L S
CCCGGAGCGCTCTGAAAGACTTTACCGTCAGCGGAAACCTCCTGTTTATCAGACTGACAGCGCTGACCATAGGCAACTGCAACTGTCTC

PRAME #31

E D I H G T L H L E R L A Y L H A R L R E L L C E L G R P S
GAGGATATCCATGGCACTGCATCTGGAAAGGCTCGCCTATCTGCATGCCAGACTGAGAGAGCTCCTGTGTGAGCTCGGCAGACCTCTCC

GAGE-1 #6

D S Q E Q G H P Q T G C E C E D G P D G Q E M D P P N P E E
GACTCCAGGAACAGGACACCCCTCAGACAGGCTGTGAGTGTGAGGATGGCCCTGACGGACAGGAAATGGATCCCCCTAACCTTGAGGAA

TRP2IN2 #3

F V I G L R V W Q W E V I S C K L I K R A T T R Q P A A
TTGTCATCGGACTGAGAGTGTGGCAGTGGGAGGTCTATCTCTGCAAACCTGATTAAAGAGAGCCACAACCAGACAGCTGCCGCT

LAGE1 #2

D A D G P G G P G I P D G P G G N A G G P G E A G A T G G R
GAGCTGACGGACCCCGAGGCGCTGGCATTCGCCATGGCCCTGGCGGAAACGCTGGCGGACCCGGAGAGGCTGGCGCTACCGGAGGCAGAA

MAGE-1 #12

P T G H S Y V L V T C L G L S Y D G L L G D N Q I M P K T G
CCCACAGGCCATAGCTATGTGCTCGTGACATGCCTCGGCCTCAGCTATGACGGACTGTCTGGCGGATAACCAATCATGCCCAAAACCGGA

MAGE-3 #9

F L L L K Y R A R E P V T K A E M L G S V V G N W Q Y P P P
TTCTCTGCTCAAGTATAGGGCTAGGGAAACCGCTACCAAGCCGAAATGCTCGGCTCCGTGGTGGCAATGGCAATACTTTTCCCT

GAGE-1 #9

T G I L W L L M N N C F L N L S P R K P A A
ACCGAATCCTCTGGCTCCTGATGAACAATTCCTTTCTGAATCTGTCCCCCAGAAAGCTGCCGCT

MAGE-3 #8

E P Q A A L S R K V A E L V H F L L L K Y R A R E P V T K A
GAGTTTCAGGCTGCCCTCAGCAGAAAGGTGGCGGAACCTGGTCCACTTTCTGCTCTGAAATACAGAGCCAGAGAGCTGTGACAAAGGCT

MAGE-1 #18

V P D S D P A R Y E F L W G P R A L A E T S Y V K V L E Y V
GTGCTGACTCGGACCTGCCAGATACGAATTCCTCTGGGAGCCAGAGCCCTGCCGAAACCTCTACGTCAGGCTCTGGAATACGTC

NYNS01a #6

G C C R C G A R G P E S R L L E F Y L A M P P A T P M E A E
GGCTGTTGCAGATGGGAGCCAGAGGCCCTGAGTCCAGGCTCCTGGAATCTATCTGGCTATGCCTTTGCTACCCCTATGGAAGCCGAA

MAGE-3 #13

A T C L G L S Y D G L L G D N Q I M P K A G L L I I V L A I
GCCACATGCCTCGGCTCAGCTATGACGGACTGTCTGGCGATAACCAATCATGCCCAAGCCGAGCTGCTCATCATTGTCTGCCCAIT

LAGE1 #3

G N A G G P G E A G A T G G R G P R G A G A A R A S G P R G
GCCAATGCCGAGGCCCTGGCGAAGCCGAGCCACAGGCGGAAGGGGACCCAGAGGCGCTGGCGCTGCCAGAGCCCTCCGGCCCTAGGGGA

Artificial Protein:

APBEEIWEELSVMEVYDGRHSAYGEPRKLEEVPTAGSTDPQSPQGASAPFTTINFTRQTVWSGNRASLYSFPEPEAAQPMTKKRKVDGQIMPKAGL
LIIIVLAI IAREGDCAPBEEKIWEELQVLDLRKNSHQDPFTVWSGNRASLYSFPELDVLLAQEVPRRWKLQVLDLRKNSHQDPWQGAMLAAQERRVPRAA
EVPGAQQCGPRGRQSPSVLSVLSLGVMLTDVSPBPLQALLTQDLVQEKYLEYRQVFDSDPARYEPLNGPRQPSGSSSREBGPSTSCILES
FRAVITAAMAAARAVFLALSAQLLQARLMKEESPVVSTFYDPEPILCPCMPNAAI EIMVDPIGHLYI FATCLGLSYDGLLGNRRYVEPPEMIGPMR
PEQPSDEVEPATPEBGEAGGFPFMLKVYYIRFVIGLRVWQNEVISCAAMERRRLNGSIQSYRISMSVMTSPRLVEAALMETHLSSKRYTERAGGFPF
WLKVYYIRAAHSLBQRSLHCKPRALEAQQEALGLVCQAATSSSPFLVLGTLEEVPTAGSTDPQSPAELLLPRELFPPLPMAAFDGRHSQTLKAMV
ELSVLEVPBEGREDSILGDPKLLTQHFPVQEBLSQLVPGIDVKEADPTGHSYVLVTCGLSFDPPQSPQGASSLPTTMYPLMSQSYEDSSAAMQABGQ
GTGGSTGDADGPGGPGIPDGPGQCFPLPVFLAQPPSQRRRAATWEGELPSQPIIHTCVYFPLPDHLSFGRPPSTSCILES
KYRAAMQABGRGTGGSTGDADGPGGPGIPDGPGDGPDGQEMDPFNPEVKTPEBEMRSHYVAQISSCLQQLSLLMWITQCFLPVFLAQPPSGQERASA
TLQDLVFDCCGTTDDQLLALLPSLSLGDPKLLTQHFPVQENYLEYRQVPGSDPACALEAQQEALGLVCQAATSSSPFLVLGTLEFYLAMPFATPME
AELARRSLAQDAPPLPVBEAPRGVRMAARLQGAAMRLPEPDGTALCFI PAABQFSDVEPATPEBGEPATQRQDPAAQEGTMYPLMSQSYEDSSNQ
EEBGPSTFPDLESNQBEGPSTFPDLESFPQALSRKVAELVHVDLFLKEGACDELFSYLIKVKRKIONVLRITRLTAADHRQLQLSISCLQQLSL
LHWITAMPLEQRSQHCKPEBGLERGAELGLVGADADGPGGPGIPDGPGGNAGGPGEGAGATGGRYEPLWGPRLVETSYVKVLHMMVKISGGPHITN
CRLSEGDVMHLSQSPSVLSVLSLGSNYLEYRQVPGSDPACTEFLWGPRLVETSYVIFSKASSSLQLVPGIEMLEVDPIGHLIYI FOALYVDSLPFL

Figure 27 (Cont)

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RGRLDQLLRHVMPNPLETLSYIAQFTSQFLSLQCLQALYVDSLFFLRGRGLQGHLHLETFKAVLDGLDVLVLAQEVPRRRWKFIRLTAADHRQQLQLSISSC
LQVLSLGLLMMITCCKKLIPAMPMDIKMILMOWQLODSIEDLAGPRGHGGAASGLNGCCRCGARGPESRLILKJXVADLVGFLLLKYRAREPVTKAEMLE
SVIYDGLLGDNGKMPKTCFLIIVLVMAMBGGHSISALQSLQHLGLSNLTHLVYVPVPLESYIAREBGDCAPEKINBELSVLEVFEGREDSIAEDQLLR
HVMPNPLETLSITNCLRSEGVNHLRALAEITSYVKVLEBYIVKVSARVFPFPLSRNLNTHLVYVPVPLESYIEDHGTIHLERLAYLAAMLMAQALAPAL
MAQGMALAAQERVMTPRKNYHCIPBEIPGKASESLQLVPGDIDEBADTLVBEVTGLBEVPAABSPDTPQSPQGAASSLPTHARILRELCELGRPSHMVWLSA
NPCPHCGDRVRLTVSPPEPLQALLERASATLQOLVDFBCEDEGASAGQGPKEADSQEQGHPPDQCECEBHEILGSVGNWQYFFVPIYKASSLSQLVP
GAAMSVEGRSTYRPRPRRYVEPEMIGPMRYTSMVMTSPRRLVELAGQKPLDLKDEALAIYDGREHSAYGEPRKLLTQDLVQEKYLETREVQCCFLVPV
LAQAPSGORRAAVKVLHHMVKISGCPHISYYPPLHEWVLRBGEQLHITMPPSSPMBABLVRRIISRDAAPLPRPGVLLKEPTVSGNIIILIRLTAADHRQ
QLQSLKTHLMWQLODSIEDLEVTCWKLPKLTAAPLESFLIIVLVMAMBGGHAPBEIINBELSVLEVEVTCWKLPKLTAAPSPYLGQMINLRLLLEGLE
ARGALGLVGVAQAPATEBQEAASSSITYPPLHEWVLRBGEAAHIIHASSYISPEKEEQYIAQFTSQFLSLQCLQNGAGGPEGAGATGGRGPRGAGAAR
ASGPGGGPRGAGAARASGPGGGAAPRGPHGGAASGLMQASAPFTTINFTQRQPSSEGGSSSREEBGLARRSLAQADAPPLVPVGVLLKEPTVSGNIIILAA
FDGRHSQTLKAMWQAPFTCLPLGLVMKIKVSARVFPFPLSRREALREBEEGVAAGITDDQLLALLPLSLSHCSQLTLSFYGNSIVKTPBEEBMSHY
VAQTGILGLMNCFLNLSISSCLQSLSLMMITQCFPLVPLVAQAPSQQYILBKVKRJOXNLRLLCKKLIKIFAMPMDIAREPVTKAEMLESYIKNTKH
CFPEIPGKASLVRRILSRDAAPLPRPGAVLDQFTVSGNLHCSQTLTIPGNSISISALQSLQHLGLMVLWAMPCPHOGORTFYDPEPILPCFP
MPAASNSQSGHSFVYVWKTWGEBLPSQPIHTCLLQARLMKESPPVSNRLREBEGTALCFIPVYFQPLPHLSLPGRPHIANCFDPLAAPPYLGQMINLR
LLLSHIIHASSYISPEKEEQQAPATEBQEAASSSITVBEVLTEGVEPAABESQAWPTCLPLGVLMKQHLHLETFKAVLDGLSTREABQPPFIVEVLVDLP
LKEGACILPSAEVPGACQGGQPGREBAPRGVMAARILGCGAPRGPHGGAASAGDGRCCPAGRRPDRLLEPRGAGAARASGPRGAPRGPHGGAAS
AQDLAQGSLKDEALAJALEKILPRELFPPLPWEPAQRQDPAQAQCEDEGASAGQGPKEAPEAAQPMTKKRVLDGLSTREABQPPFIVEVLGRCP
GARRPDQSRMLQDNLITMPPSSPMBEAPGVLDQFTVSGNLFLIRLTAADHRQQLQSLIEDHGTIHLERLAYLHARLRELLCELGRPSDSQEQGHQPTQCE
CEGDFDGGEDPPHPEBFPVIGLRVQWVEYISCKLIKRAATRPAAADGPGGPGIPDQPGGNAGGPEGAGATGGRTPHYSVLVTICGLSYDGLGDGN
QIMPKTGFLLLKYRAREPVTKAEMILGSVGNWQYFFFTGILMLLMMNCFLNLSPRKPAEPQAALSRKVAELVHFLLLKYRAREPVTKAIPVDSOPARY
EFLMGPRALAEITSYVKVLEBYVCCRCGARGPESRLIEPYLAMPPATEMREBATCIGLSYDGLLGDNGKIMPAGLLIIVLAIGNAGGPEGAGATGGRGP
RCAGAARASGPRG

Artificial DDA:

GCCCTCTAGGAAGAGATTGGGAAGAGCTCAGCGTCATGGAAGTGATGACGGAAGGGAACACTCCGCTTATGGCGAACCCAGAAAGCTCGAGGAAGT
 GCCTTACCGCTGCTCCACCGATCCCCCTCAGTCCCCCAGGGCGCTAGCGCTTTCCCTACCACAACTCAATTTTCACAAGGCAAAACCGTCTGGTCCGGCA
 ATAGGCGTAGCCTCTACTCTCTCCCTGAGCGCTAGGCTGCCAACCCATGACCAAAAGAGAAGGTTCGACGGACAGATTATGCCCTAAGGCTGGCCCTC
 CTGATTATCGTCTGCGCTATCATTTGCCAGAGAGGGAGACTGTGCCCTCGAGGAAAGATTGGGAAGTTCGAAGTGTCCAGCTCAGGAAAAAATCCCA
 CCAAGACTTTTGGACAGTGTGGAGCGGAACAAGAGCCTCCCTGTATAGCTTTTCCGGAACTGGATTGTCTCTCGCTCAGGAAGTGAAGCCAGAAGGT
 GGAAGCTCCAGGTCCTGGATCTGAGAAAGAAATAGCCATCAGGATTCTGGCAGGAGGACCATGCTGGCTGCCAAGAGGAAGGTTCCCGAGCGCCT
 GAGGTCCCGCGGCCCAAGGCCAAGCGGACCGAGGACCGAGGACAGTCCCTCCGTGTCTCCAGCTCAGCGCTCTGTCCCTCGGCGTATGCTCAC
 CGATGTGTCCCGGAACCCCTCCAGGCTCTGTCTCTGACACAGGATCTGGTCCAGGAAAGTATCTGGAATACAGACAGGTCCCGATAGCGATCCC
 CTAGGTATGAGTTTCTGTGGGCGCTTAGGCAACCCCTCGAGGGAGGCTCCAGCAGAGGAGGAGGAGGCCCTCCACCTCTGCTGATTCTGGAAGAGCTC
 TTACAGGCGGTATACACAGCGCTATGTGCTGCCACAGCGCTTTCTCGCCCTCAGCGCTCAGCTCTCTCGAAGCCAGTACTGAAGGAAGAGTCCCT
 CGTGTGTCCACCTTTTACGATCCCGAACCATTCTGTGTCCCTGTTTCATGCCCAATGCGCTATCGAACTGATGGAGGTGACCCCTATCGGACACC
 TCTCATTTTGGCTACTCTGTGGGACTGTCTACGATGGCTCTCGGGAGCAATAGGAGATACGTGAGCCTCGGGAATGATTGGCCCTATGAGA
 CCGGAACAGTTTATGAGATGAGGTGAGCTGACCTGCAACCGGAAGAGGAGGAGCGTGGCGAGTTCTTTCCCTGGCTGAAAGTATATTACTATAGCTTTGT
 GATTGGCCTCAGGGTCTGGCAATGGGAAGTGATTAGCTGTGCCGCTATGGAAGGAGAAGGCTCTGGGGAAGCATTAGTCCAGGTATATCTTCCATGT
 CGTGTGCAAGCTCCCGCAGAAGGCTGTGGGAAGCGCTCTGATGGAGACACACCTCAGCTCCAAGAGATACACAGAGGAAGCGGAGGCTTTTCCCT
 TGGTCAAGTCTACTATTACAGAGCGCTATGTCTCTGGAACAGAGAAGCCTCCACTGTAAAGCTGAGGAAGCCCTCAGAGGCTCAGCAAGAGGCTCT
 GGAAGTGTCTGTGGTTCAGGCTGCCAACAGCTCCAGCTCCCCCTCGTGTGGCACACTGGGAAGAGTCCCAACAGCGGAAGCACAGAGCCCTCCC
 AAGCCCTCTGCCCTGAGCTCTCTGCCATAGGAACTGTTTCCCCCTCTGTTTATGGCTGCTTTGACGGAAGGCATAGCTCAAACCTCTAAGGCTATGGTC
 GAGCTCAGCGCTCTGGAAGTGTGTGAGGAAGGAAGACATCCATCTCGGCGACTCCAAAAGAGCTCTTGACAGCAAGCTTTGCTCCGGAAGAGTCCCT
 GCAACTGTCTTGGAAATGATGTGAAGAGGCTGACCTTACGGACCTCAGCTCTGTGTCTGAGTGTCTGGAGCTGTGCCCGATGCCCTCAGT
 CCCCACAGAGGCGCTAGCTCTCTGCCATCAACAAATGAATTAACCTCTGTGGAGCCAAGCTCTGAGATGATGTCCGCGCTATCTGACGCCGAAGGCCAA
 GGCACAGGCGGAAGCACAGGCGATGCGGATGGCCCTAGGCGAACCCGGAATCCCTGACGGAATCCGGGACAGTGTCTTCCCTCCCTGCTCTCCGCCAACCC
 CCTAGCGGACAGAGAAGGCTGACACTGTGGGCGAGGCGCTCCCTCCAGCTATCATTCACACATCGCTCTACTTTTCTCTCCGATCACTCTA
 GCTTTGACAGACCTTTAGCACAGCTGTATCTCTGAGTCCCTGTTTAGGGCTGTGATTACCAAAAAGTGGCGGATCTGGTGGCTTTCTGTCTCTG
 AATACAGAGGCGCTATCTGACAGCGAGGACAGGACAGGCGGATCGGATGCTGCTGGCGAGACCCGAATCCCTGACGAGGACCGG
 AGAGCCAGCGGATGCGCACAGATGGAACCTCCCAATCCCGAGAGGTCAAGACACCGGAGGAGGAATGAGGAGCAATTAOGTGGCCAAATTCACA
 GCTGTCTGCAACAGCTCAGCCTCTGATGTGGATTACCCAAATGCTTTCTGCTGTGTTTCTGGCTCAGCCTCCCTCCGSCAAGAGAGGCTCTCGCC
 ACACCTCAGAGACTCGTGTGTGTGAAGAAATCGGAATACAGACGATCAGCTCTCGGCTCTGCTCCCTCCCTGTCCCTGGGAGACCCCTAAGAAATCTGT
 CACCCAAACCTTTGTGCAAGAAATTAACCTCGAGTATAGGCAGTGCTGCTGCTCGACCCCTGCTGTGAGGCTCTGGAAGCCCAACAGGAAGCCCTCG
 GCCTCGTGTGTGTGCAAGCGCTACTCTCAGCTCCAGCCCTCTGGTCTCGGAACCCCTCGAGTTTACTCTGCGCATGCCCCCTTGGCACACCCATGGAG
 GCTGAGCTCGCCAGAAAGTCTCTGGCTCAGGATGCCCTCCCTCCCGTCCGAGGAGCCCTAGGGGAGTGAAGTGTGCTGCCAGACTGCAAGGCGC
 TGCTCTGGAGCTGAAGACCGGAAGACGGAACCGCTCTGTGTTTCAATTTGCTGCGGAGCAATTCTCCGACGAAGTGAAGACCCGCTACCCCTGAGGAAG
 GCGAACCCGCTACCCAAAGGCAGACCTTCGCGCTGCCAGAGGGAACCATGAACATTTCTCTGTGTCAGCTCTCAGAGACTCCAGCAATCAG
 GAGAGGAAGGCGCTAGCACATTCCTGACCTCGAGTTCACCAAGAGAAGAGGAGCCCTCCACCTTTCCCGATCTGGAAGCGAATTCACAGCCGC
 TGTGTCAGGAAATGGCTGAGCTGCTGTCATGGAATCTGTTTCTGAAAGAGGAGGCTGTGACGAAGTGTTAGTATCTGATCTGGAAGATGGA
 GGAAAGAAAGAAATGTCTCAGGCTCACCATTAGGCTCAGCGCTCGGATACAGACAGCTCAGCTCAGCATAGCTCTCGCTCCGAGCACTGTCTCGCT
 CTCATGTGATACACAGCGCTATGCTCTGGAACAGAGAAGCCAAACACTGTAGCCCTGAGGAAGGCTCGAGGCTAGGGGAGAGGCTCTGGGACTGGT
 CGGCGCTGAGCTGACGAGCAGCGAGGCCCTGGCATTCGCGATGGCCCTGGCGGAAGACGCTGAGCGGACCCGAGAGGCTGGCGCTACCGGAGGAGAT
 ACGAATTTCTCTCGGGAACCCAGAGCTCTGTGGAACCTCTACCTCAGGCTGCTGATCTGAGGTGAAATATCTCCGGCGACCCCATATCAAAAC
 TGTAGGCTCAGCGAAGGCGATGTGATGACCTCAGCCAAGCCCTAGCGTCAGCCAACCTGTGCTGTCTCAGCTCAGCGGAAACTCTGGAATACAG
 ACAGGCTCCCGGAGAGCGATCCCGCTTGTGATGATTCTGTGGGGCCCTTAGGGCTCTGTGTGAGACAGCTATGTGATTTTCTCCAGGCTAGCTCCA
 GCTCTCAGCTCGTGTGTGGCATGTAGCTCATGGAATGGAATGCCATTTGGCCATCTGATATCTTTCAGGCTCTGTATGGATAGGCTCTTCTTCTGT
 AGAGGACAGCTGGATCAGCTCTGTAGACAGCTGAATCCCTCGAGACAGCTGCTACATTTGCCAAATACAGAGCCAATTCCTCAGCCTCCAGT
 TCTGCAAGCGCTCTACGTGAGCTCCCTGTTTTCCTCAGAGGGAAGGCTCGGCCAACACCTCCACCTCGAGACATTCAAAGCCGCTCTGGAATGGCCCTG
 AQTCTGCTCTCGCCCAAGAGGCTCAGGCTAGGAAATTCATTAGGCTCAGCGCTCGGATCAGACAGACTCCAGCTCAGCATAGCTAGCTCTCTG

Figure 27 (Cont)

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CCAGCTCGACTCCATCGAAGACCTCGGCGCTCCAGAGGCGCTCAAGGAGGCGCTCGCTCCGCGCTCAAGGATGCTGTAGGTGTGGCGCTAGGGGAC
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TCCGTGATTATAGATGGGCTCTCGGGAGACAATCAGATTATGCTTAAGACAGGCTTTCTGATTATGCTCTGCTCATGATTGCCATGAGAGGAGGCCA
TAGCATTAGCGCTCTGCAAGCCCTCTGCAACACCTCATCGGACTGTCCAACCTCACCATGTGCTCTACCTGTGCGCTCTGGAAGGCTATATCGCTA
GGGAAGGCGATTGCGCTCCGGAAGAGAAATCTGGGAGGAATCTGCTGCTCGAGGCTCTGGAAGGCGAGAGGATAGCATTGACCAACTGCTCAGG
CATGTGATGAACCCCTCTGGAACCCCTCAGCATTACCAATTGACAGACTGTCCGAGGAGAGCTCATGCTCTGTCCAGGGCTCTGGCTGAGACAAGCTA
TGTGAAAGTGTGAGTATGTGATTAAGGTACGCGCTAGGGTACGGTTTTCCTTTCCCTCCCTGAGAAGCAATCTGACACACGCTCTGTATCCCGTCC
CCCTCGAGTCTTACGAAGACATTACGGAAACCCCTCCACCTCGAGAGACTGGCTTACCTCGCGCTATGCTCATGGCTCAGGAAGCCCTCGCTTTCTG
ATGGCCCAAGGCGCTATGCTCGCGCTCAGGAAGGAGAGTGCTTAGGGCTAAGAAATTACAAACACTGTTTCCCTGAGATTTCGGAAGGCTAGCGA
AAGCTCTCAGCTGTGTTTGGCATTGACGTCAAGGAAGCGATACCTCGTGGAGTACACTGGGAGAGGTCCTCGCTGCGGAAGCCCTGACCCCTC
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TCTGCTCTTCATGATGTGAGGATGAGGGAGCCTCCGCGGACAGGGAGCCCAACCGAAGCCGATAGCCAGAGCAAGGCCATCCCAACCGGAT
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GGAGCCCTATGTCTCGAGAGGCAAGACATACAGACCCAGACCCAGAGGATATGTTGAACCCCTGAGATGATGGAGCCCTAGGGCTCTACAT
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ATGCGCTCCCTCCCAAGCCCGAGTGCTCTGAAAGAGTTTACCGTCAAGGAAACATCTGACAACTCAGACTGACAGCCGCTGACCATAGGCA
TGTCAACTGTCCAAAGATGCTCAGATGGTCACTGATAGCTTGAAGTATGGAAGTATGGAAGTATGGAAGTATGGAAGTATGGAAGTATGGAAGT
CTCCTCTCTCATCTTGTCTGTGATGATGCTATGGAAGGCGGACAGCTCCCGAAGAGGAAATCTGGGAGGAACTGTCCGTGATGGAGTGGAGG
TCACTGTACCTGGAAGCTCCCAACACTGGCTAAGTTTAGCCCTTACCTGGGCCAAATGATTAACTCAGGAGACTGCTCTGTCCGAGGAGACTGGA
GCCAGAGCGAAGCCCTCGGCTCTGTGGAGGCCCAAGCCCTTCCACAGGGAACAGGAAGCCGCTAGCTCCAGCTCCATCTCTACCTCCCTCCCA
CGAATGGGTCTGAGAGAGGAGAGGAGCCGCTCATTACGCTAGCTCTTACATTAGCCCTGAGAAAGAGGAACAGTATATCGCTCAGTTTACCT
CCAGTTTCTGTCTCCCTGCAATGCTCTGGCAATGCGGAGGCCCTGGCGAAGCCGAGCCACAGGCGGAAGGGGACCCAGAGGGCGCTGGCGCTGCCA
GCCCTCGGCGCTGGCGAGGCCCTAGGGAGGCCCGCTAGGGCTAGGGCTAGGGCTAGGGCTAGGGCTAGGGCTAGGGCTAGGGCTAGGGCTAGGGCT
CGGACTGAATCAGGAGCCCTCGGCTTTCCCAACCACTTAACTTTACAGACAGAGACAGCCTAGCGAAGGCTCCAGCTCCAGGGAAGAGGAAGGCC
CTCTGGCTAGGAGAGGCTCGCCCAAGAGCCCTCCGCTCTGCTGTGCTGGGCTCTGCTCAAGGAATTCACAGTGTCCGGCAATATCTCTCGCGCT
TTGATGGCAGACACTCCAGACACTGAAGCCATGGTGAAGCCCTGGGCCCTTACCTGTCTGCTCTGGAGTGTCTCATGAATCAAAAGTGTCTCC
CAGAGTGAGATTCTTTTCCCTAGCCTCAGGGAAGCCGCTCTGAGAGAGGAAGAGGAAGGCGTGGCGCTGGCATTACGATGACCAACTGCTCGCC
TCTGCTAGCCTCAGCAATTGCTCCAGCTCACCACACTGCTCTTCTATGGCAATAGCATTGTGAAGAACCCCTGAGGAAGAGATGAGGTCCCACTA
GTGGCTCAGCAGGCACTTGTGGCTGTCTCATGAATAACTGTTTCTCTCAACTCATCTCCAGCTGTCTGCAACAGCTCAGCCTCTGATGTGGATTAC
CCAATGCTTTCTGCTGTGTTTCTGGCTCAGGCTCCCTCGGCAATACCTCATCGAAAGGTCAGAGAAAGAAAGCTCTGAGACTGTGTTGCA
AAAGCTCAAGATTCTTGGCTATGCTATGCAAGACATTGCCAGAGAGCCTGTGACAAAGGCTGAGATGCTGGAAAGCGTATCAAAACTATAGCA
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GCTCCAGGCTAGGCTCATGAAGAGGAAAGCCCTGTGCTCAGCTGGAGCTCAGGCTAGGATGGCACAGCCCTCTGCTTTATCTTTGTGATTCT
TTCTGCTGACCATCTGTCTCTGGAAGGCCCTTTCCATCTGAATTTCTGTGACTTTCTGGCTGCCCTATCTGGGACAGATGATCAATCTGGAAGG
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CAGCACTGCTGAGGTACCTCCGCTGGCGAAGTGCCTGCGCTGAGTCCAGGCTTGGCTTTACATGCTCTCCCTCGGCTCTGATGAAGGAG
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CTCAAGAGGCGCTTGGATGAGCTCTTCTCCGCGAAGTGCCTGGGCTCAGGACAGCAAGGCCCTAGGGGAAGGGAAGAGGCTCCAGAGGCGT
CAGGATGGCGCTAGGCTCCAGGAGGCGCTCCAGAGGCCCTCAGGAGGCGCTGCTCCGCGCAAGAGCGGAAGGTTGCTCTGTGGGCTAGGAGAC
CGGATAGCAGACTGCTCGGCTTAGGGAGCGGAGCGCTAGGGCTAGGAGCCAGAGGCGGAGGCCCTAGGGGAGCCCAAGCGGAGCGGCTAGC
GCTCAGGATCTGGCTGGCAAGCCCTCTGAAAGAGCAAGCCCTGGCCATTGCGCTCTGGAAGTGTCTCCCAAGAGAGCTCTTCCCTCCCTCTTCT
GGAGCTGCCACAGAGAGCAGGATCCGCTGCGCTCAGGAAGGCGAAGAGCAAGGCGCTAGGCTGGCCAGGCGCTAAGCCTGAGGCTCCCGAAG
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GGAGCCAGAGGCGTACTCCAGGCTCTGCAACTGATATACAAATGCCCTTTCTCAGCCCTATGGAAGCCGAACCCGAGCGCTCTGAAGAGATT
TACCGTCAAGGAAACCTCTGTTTATCAGACTGACAGCGCTGACCAAGGAACTGCAACTGTCCGAGGATATCCATGGCACTGCATCTGGAA
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CAATCATGCCAAACCGGATTCCTCTGCTCAAGTATAGGGCTAGGGAACCGCTCACCAGCGGAATGCTCGGCTCGCTGCTGGCAATGGCA
ATACTTTTCCCTACCGGAATCTCTGGCTCTGATGAACAAATGCTTTCTGAATCTGTCTCCCAAGAGCCTGCGCTGATTTACGCTGCCCTC
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CAGGCTCTGGAATTTCTATCTGCTATGCTTTGCTACCTATGGAAGCGAAGCCATGCTCGGCTCGGCTCAGCTATGACGAGTGTCTGGGAT
ACCAATCATGCCAAAGCGGAGTGTCTCATTTGTGCTGCCATTGGCAATGCGGAGGCCCTGGCGAAGCCGAGCCACAGGCGGAAGGGGACCC
AGAGGCGCTGGGCTGCCAGAGCCTCGGCGCTAGGGGA

Figure 27 (Cont)

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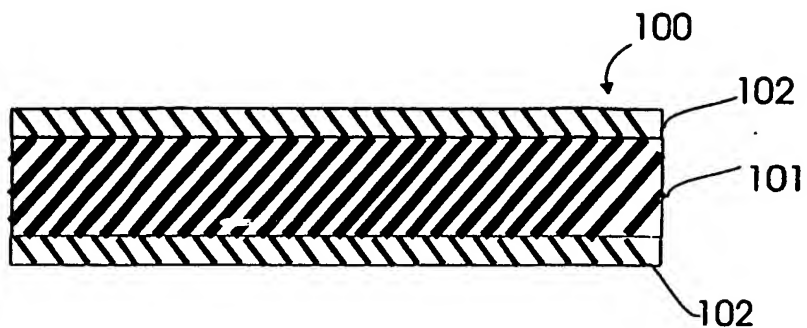


FIGURE 28

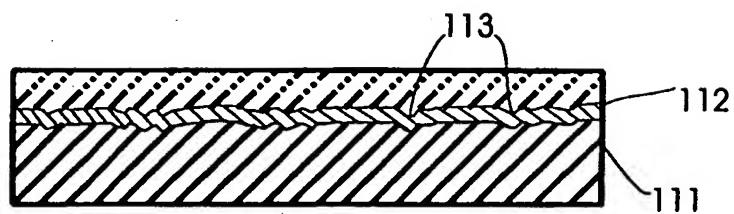


FIGURE 29

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Cassettes for construction of a full-length HIV Savine

Cassette A1

ggatccaccATGACAGGCCCTTGACAAACGTCAGCACCGTGCAATGCACACACGGAATCAGACCCGTCGTGTCCA
CCCAACTGCTCCTGAATGGCTCCCTGAGAAGCCTCTACAATACCGTCGCCACACTGTGGTGGCTCCACCAAAGGAT
TGACGTCAGGGACACAAAGGAAGCCCTCGACAAAATCGAACTCGGCGATGGCGGAGGCGCTGAAAGGCAAGGCACC
TCCAGCTCCTTCAACTTTCCACAAATCACACTGTGGCAAAGGCCTCTGGTCACCGAACCCCTTCAGAAAAAAGAATC
CCGATATGGTGATTTACCAGTACATGGACGATCTGTATGTGGGAAGCGATCTGGAAATCGGACAGCATTTTACCAC
ACCCGATAAGAAACACCAAAGGAACCACCATTCCTCTGGATGGGATACGAACTGCATCCCGATAGGTGGACCGTC
CAGCCTCTTAATTTCCCTCAGATTACCTCTGGCAGCGTCCCTCTCGTGACAATCAAAATCGGCGGACAGCTCATAG
AGGCTCTGCTCGACACAGGCTCCTATGGCAGAAAGAAACGTAGGCAACGTAGACGCGCTCCTCAGAGCAGCAAGGA
TCACCAATACCCCTATCTCTGAGCAACCCCTCTCCTTCTTTAGGGAAAACCTGGCTTTCCAGCAAGGTAAAGCCAGA
GAGTTTTCCAGCGAACAGACAAGAGCCAATAGCTCCGCCTCCAGGAAGAGCCCCCAAATCTCCGGCGAAAGCTCCG
TCATTCTGGGATCTGGCACCAAAAACGCCGCTACTAGAAGAATCGAAGTGAAAGATACCAAAGAGGCTTTGGATAA
GATTGAGGAGGTGCAAAAGAAAAGCGAGCAAAAGACACAACAGGCTGCCGCTAAAGCCGGATACGTACCCGATAGG
GGAAGGCAAAAGATTATCTCCCTGACAGAGACAACCAATCAGAAAACCGAACTGCATGCCATTCAAGAAGCCACTA
CCCACTGTTTTTGCGCCAGCGATGCCAAAGCCTATGAGACAGAGGTCCACAATGTGTGGGCCACACACGCTTGCGT
CCCCGCTGACGATACAGTGCTGGAGGAGATGAACCTCCCGGAAAATGGAAGCCTAAGATGATTGGCGGAATCGGC
GGATTCAATTAAGGTGAGAAAAATCGGACCCGAAAACCCCTTACAATACCCCAATCTTCGCTATCAAGAAAAAGGACT
CCACCAATGGAGAAAGCTCGTGGATTTAGAGTTAGGATTATCAATATCCTCTACCAAAGCAATCCCTATCCTAG
CTCCGAAGGCTCCAGGCAAAACAGAAAGAATAGGAGAAGGAGATGGGGAGGCGAACCGGGTAGGGATAGGTCCGTG
AGACTGGTCAACGGATTCTTAGCCCTCGCCTGGGACGATCTGAGAAACCTCTGCCTCTTCGAAAACCTCTGGGTCA
CCGTCTACTATGGCGTCCCGTCTGGAGAGAGGCTGCCACAACCCCTCTTCTGTGCCTCCGACGCTAAGGCTTACGC
TGCCATGGCTGGCAGAAGCGGCGGCACAGACGAAGAGCTCTGAGGGCTATCAGAATCATTAACTTCTGTATCAG
TCCAACCCCTTACCCTTCCGCTAGTATGAGAATCAGAACCTGGAACAGCCTGGTCAAGCATCACATGCACATCTCCA
AGAAAGCCAAAGGCTGGTTCTATAGGCATCACTTTGAGGAGTCCGAGCTCGTGAATCAGATTATCGAAAAGCTCAT
CAAAAAGGAAAAGGTCTACCTATCATGGGTACCAGCCCAAGGGAATCGGACAAACCAAGAGCTCCAGAAACAG
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GTGCCCTAGCGAAGAGACAACCCCTAGCCAGAAAACAGGAACAGAAAGACAAAGAACTCTACCCCTTTAGCCAGC
CTCAAGTCCCTGTTTGGCAATGACAATTTCAATATGTGGAAGAATGACATGGTGGAAACAGATGCAAGAAGACATTA
TCTTACTATGGGACCAAGCCTCAAGCCTTGGCTCAAGCTCGACGTCGGCGATGCCTATTTCTCCGTGCCTCTGGA
TAAAAACTTCAGAAAGTATACCGCTTTTACAATCCCTAGCACAAAACATGAGCAACTGAAAGGCGAAGCCATCCAT
GGCCAAGTGAATTGCTCACCAGGCATTTGGCAACTGGATTGCACACACCTGGAGGGAAAGATTATCCCTAAGGTCA
AGCAATGGCCTCTGACAGAGGAAAAGATTAAAGGCTCTGACTGAGATTGCAAAGAGATGGAGGAAGAGGGAAAAGAT
TAGCATGGATGACCTCTACGTCGGCTCCGACCTGG

FIGURE 30

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AGATTGGCCAACATAGGACCAAAATCGAAGAGCTCAGGGAACACCTCCTGAAATGGGGACTCACCGAAACCACAAA
CCAAAAGACTGAGCTCCAAGCTATCCATCTGGCTCTGCAAGACTCCGGCTTAGAGGTCAACATTGTGACAGACATT
CCCGCTGAGACTGGTCAAGAGACCGCCTTTTTTCATTCTGAAACTGGCTGGCAGATGGCCTGTGAAAGTCATTACACA
CAGACAATGGCAGGACAAAGATTGAGGAACTGAGACCGCATCTGCTCAAATGGGGCTTCACAACCCCTGACAAAAA
GCATCAGAAAAGAGCCTCCCTTTCTGTCTAGTGTCAAGAAACTGACAGAGGATAAGTGGAACGAACCCCGAGAAAATC
AAGAGACGCAGAGAAAATCACACAATGAATGGCCATACTGCCACAGAGTCCAGAAATCAGCAAGACAGAAAACGAAA
AGGAACTGCTGGAGCTCGACAAAATGGGCAAGCCTCTGGAATTGGTTTAACATTACCGACACCGGAAATAGCTCCAA
AGTGTCCAGAAATTACCCTATCGTCCAGAATGTCCAAGGCCAAATGGTCCACCAACCCCTCTCCCCAGACTCATC
GGACTGAGAATCGTTTTCTGCTGTGCTCAGCATTATCAATAGGGTCAGGCAAGGCTATAGCCCTCTGTCTTCCAAA
CCCTCCCCCTCATCCATCTGCAA!ACTTTGACTGTTTCTGCTGACTCCACCATTAGGAGAGCCATCTTGGGACACAT
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ATGGGCGCTGCCTCCATGACACTGACAGTGAAGCCTATGACCCTAGCAAAGACCTCATTGCTGAGATTGAGAAAC
AGGGCCAGGGTCAGTGGACATTTTCAAGAGCCTTTCAAAAACGGAACCGTCTGCTGCGCCCTACACC
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GGGCGAAAACAATTGCCCCCTGTTTAGGAAATACACAGCCTTTACCATTCCCTCCATCAATAACGAAACCCCTGGC
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TCATGTTCACTACTTTAGGATTGGCTGCCAGCACTCCAGGATTGGCATCATCCGTGAGAGAAGGGCCAGAGCTCC
CAGGAAAAAGGGATGCTGGAAGTGTGGCAGAGAGGGACACCAGATGAAGGATTGCACTGAGAGACAGGCTAATTTT
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GCTGCTGCCATGACACCCCTGGAGATCATCGCTATCGTCGCCTTTATCGTCGCCCTCATCATAGCCATTGTGGTCT
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Figure 30 (Cont)

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A2 fragment

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tagcatggatgacctctacgtcggctccgacctggagattggccaacataggaccaaaatcgaagagctcagggca

Figure 30 (Cont)

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CTGCTCAAATGGGGCTTCACAACCCCTGACAAAAAGCGTCAGAAAGAGCCTCCCTTTCTGTCTAGTGTCAAGAAAC
TGACAGAGGATAAGTGAACAAACCCAGAAAATCAAGGGACACAGAGAAAATCACACAATGAATGGCCATGCTGC
CACAGAGTCCCAGAATCAGCAAGACAGAAACGAAAAGGAACTGCTGGAGCTCGACAAATGGGCAAGCCTCTGGAAT
TGGTTTAACATTACCGACACCGGAAGTAGCTCCCAAGTGTCCAGAATTACCTATCGTCCAGAATCTCCAAGGCC
AAATGGTCCACCAACCCATCTCCCCAGACTCGTGGACTGAGAATCATTTTCGCTGTGCTCAGCATTATCAATAG
GGTCAGGCAAGGCTATAGCCCTCTGTCTTCCAAACCCCTACCCCTCATCCATCTGTATTACTTTGACTGTTTCGCT
GACTCCACCATTAGGAGAGCCATCCTTGGACACAGAGTGAGCAGGAGATGCGAATACGCTGTGGGAATCGGAGCCA
TGTTCCCTTGGCTTTCTGGGTGCCGCTGGCTCCACCATGGGCGCTGCCTCCATCACACTGACAGTGCAAGCCTATGA
CCCTAGCAAAGACCTCATTGCTGAGATTGAGAAAAGGGTCAGGATCAGTGGACATATCAGATTTTCCAAGAGCCT
TTCAAAAACGGAACCGTCTGGTCCGCCCTACACCCGTCAACATCATCGGAAGGAACCTGCTGACACAGATAGGCT
GCACCCCTCAACTTTCCATTAGCAAAGGCAGCCCTGCTATCTTTCAGTCCAGCATGACACAGATTCTGGAGCCTTT
TAGGAAACAAAACCCCTGACATGGTCATCTATCAGTATCCTAGCCCTCTGACATTGCGATGGTGTTCAAACTGGTC
CCCGTGGACCCAGCGAAGTGAAGAGACCAACAAGGGCGAAAACAATTGCCTCCTGTTTAGGAAATACACAGCCT
TTACCATTCCTCCACCAATAACGAAACCCCTGGCATTAGGTATCAGTATAACGTCCTGCCTCAGGGATGGGGAAG
CACAATGGGAGCCGCCAGCATGACCCTACCCGTCCAGGCTAGGCAACTGCTCAGCGGAATCGTCCAGCAACAGAAC
AATCTGCTGGAGGAGAATAGGGAATCCTCAAAGAGCCTGTGCATGGCGTCTACTACGATCCCTCCAAGGATCTGA
TCGCTGAAATCCAAAGCAAGGCACAGAGGAACTGTCCGCCCTTGGTGGATATGGGAACTACCACCTCGGAGTGGGA
CAATAACCTCGCCGCTATTAGAATCCTGCAACAGCTCATGTTTCATTCACTTTAGGATTGGCTGCCAGCACTCCAGG
ATTGGCATCATCCGTGAGAGAAGGGCCAGAGCTCCAGGAAAAGGGATGCTGGAAGTGTGGCAAAGAGGGACACC
AGATGAAGGATTGCACTGAGAGACAGGCTAACTTTCTGGGAAAGGATGCCAGACTGGTTATCAAAACCTATTGGGG
ACTGCATACCGGTGAGAGAGACTGGCACCTCGGCCATGGCGTCAGCATTGAGTGGAGGACAAGGGAAAGGGCTGAG
GATAGCGGCAACGAAAGCGAAGGCGACAGAGAAGAGCTCAGCACAAATGGTGGACATGGGCAATTACGATCTGTCTA
GCCCTGCCCCAGGGGACCCGATAGGCTGGAGAGAATCGAAGAGGAAGGCGGAGAGCAAGACAGAGACAGAAGCGT
CAGGCTCGTGAATGGCAGTGAGGGCGAGGAAGTCAATAAGGGAGAGAATAACTGTCTGCTCCACCCTATGAGTCAA
CATGGCATGGAAGACGAAGACAGAGAGGTCAATAGCGATATCAAAGTGGTCCCAGAAAGGAAAGCCAAAATCATT
GGGATTACGGAAGCAAATGGCTGACGATGACTGTGTGGCCGGCTTCTCTTCCGAGCAAACAAGGGCTAACTCCCC
TGCAAGCAGAAAGCTGGGAGACGGAGCGGAGCCGACAGACAGGGAACAAGCTCCAGCTGTTTCAATTGCGGCAAA
GAGGGACACATTGCCAAAAGCTGTAGGGCCCTCGCAAGAAAGGTTGTTGGAATGCGGAAGGGAAGGCCATCAAA
TGAAAGACTGTACCGAAAGGCAAGCCAATTTCTCGGCAAAATCTGGCCCTCCAAAAAGGCAGACCCGAAACTT
TCTCCAAAGCAAATGGCTCTGGTATATCAAAATCTTTATCATGATCGTGGTGGACTGATTGGCCTCAGGATTATC
TTTGCCGCTCTGTCCATCATTAAACGGGGCCGTGAGCCGAGACCTCGATAAACATGGCGCTATTACAAGCTCCAATA
CCGCTGCCAATAACCTGACTGTGTCTGGCTGGAGGCTGCTGCCATGACACCCCTGGAGATCATCGCTATCGTCGC
CCTTATCGTCGCCCTCATCATAGCCATTGTGGTCTGGACAATCGTCTACATTGAGTATGTCGACTgaagatctgaa
ttc

Figure 30 (Cont)

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B1 fragment

ggatccaccatgctcgagaatatgctcaccCAAATCGGATGCACACTGAATTTCCCTATCTCCCCATTGAGACAG
TGCTGTGAAACTGAAACCCGGAATGGATGGCGCCGACCTTTAGGCCTGGCGGAGGCAATATCAAAGACAATTG
GAGAAGCGAACTGTATAAGTATAAGGTCGTGAAGATTAAGCCTCTGGGAATCACATGGATTCCCGAATGGGAGTTC
GTCAACACACCCCCACTGGTCAAGCTATGGTATCAGCTGGAGAAAAGACCCTATCGTTGGCGTTGAGCCTCAGGATC
TCAACACGATGCTGAATCTTGTAGGAGGCCATCAGGCCGCTATGCAAATGCTGAAAGAGACAATCAATGAGGAAGC
CTCTGTCTGTTTCTGGATGGCATTGACAAAGCTCAAGAGGAACATGAAAAGTATCACTCCAACCTGGAGGACAATG
GCCAACGACTTTAATCTGATGAAGCATCTCGTCTGGGCCTCTAGGGAGCTGGAGAGATTTCGCTCTGAATCCAGCC
TGCTGGAGACATCCGAAGGCTGTGAGCAAAATTGCTGAGGAAGAGATTATCATTAGGTCCGAGAATTTACAAACAA
TGTCAAAACCATATCGTCCAACCTCAACGAAAAGCGTCGAGATTAAATGAGGCGCTAGGGCTAGTGTCTCAGAGGC
GGCAAGCTGGACGCTGGGAAAAGATTAGGCTCAGGCCCTGGCGGAAAGAAAAGTATAGGCTCAAGGAGAAGGGAG
GCCTGGAGGGACTGGTTTACTCCAAAAGAGGCAAGACATTCTGGATCTGTGGGTGTATAACACACAGGGATTAC
TAGATGGGGAACCATGATCCTCGGCTTGGTGATTATCTGTAGCGCCAGCGAGAATCTGTGGGTGACAGTGTATTAC
GGAGTGCTGTGTGGAGGAGACAGCTCCTGTCCGGCATTGTGCAACAACAAAATAACCTCCTGAGGGCTATCGAAG
CCCAACAGCATCTGCTCCAGCTCACCCTCTGGGTGAGGCATTTCCCCAGGCTTGGCTCCACGGCCTGGGACAGTA
CATCTATGAGACATACGGAGACACATGGGCGGGAGTGGAGCCCTCACAGCCCTCATCACACCCAAAAGATTAGG
CCTCCCCTCCCATCCGTGAAAAGCTCACCGAAGACAGATGGAATGAGCCTCAAAGACATATAGCGCTGGCGAAA
GGATTATCGATATCATTGCATCCGACATTGAGACTAAGGAACTGCAAAGCAAATCCTAAAGATTGAGAAATTCGC
TGTGTTTATCCATAACTTTAAGAGGAAGGGAGGCATTGGCGGCTACTCCGCCGGAGAGAGAATCATTGACATTATC
GCCACCGATATCATTCCCGTGGGCGAAATCTATAAGAGATGGATCATTCTGGGACTCAACAAAATCGTGAGAATGT
ATCTACCCGTCAGCATCTGATATCAGAGTGAGACAGGGATACTCCCCCTCAGCTTTGAGACACTGCTGCCCCG
TCCAGAGGCCCTGACAGACTCGGAGGCATTGAGGAAGAGTCCAGCCAGGACCATCAGTATCCATTCCCGAACAG
CCTCTGCCCTCAGACAAGGGGAGACAATCCCAAGACCTTAAGGAAAGCAAAAAGGCTAGTGGAGGGGTGAGTCCA
TGAATAAGGAACTGAAAAGATTATCGACAGGTGAGGACAGGCTGAGCACCTGAAAACCGCTGTGCAAAATGGC
TGCCATGCAGATGCTCAAGGATACCATTAACGAAGAGGCTGCGAGTGGGACAGAGTCCATCCCGTCCATGCCGG
CCCGTTCCCCCTCTCACCGAGATTGTAAAGAAATGGAAGAAAGCAAAATCTCCAAGATTGGCCCTGAGAATC
CCTATAACACACCCATCTTTGCCATTCAAGTGAGAGAGCAAGCCGAACACCTCAAGACAGCCGTCAGATGGCAGT
CTTCATTACAAATTTCAAAGGAGAGGCGGAATCGGAGGCAAAAAGAAAGATAGCACAAAGTGGAGGAACTGGTA
GACTTTAGGGAGCTCAACAAACGTACACAGGATTTCTGGGAGGTCCAGCTCGGCTTTTGGCTCTGGCTTGGGATG
ACCTCAGGAGCCTGTGTCTGTTGAGCTATCACAGACTGAGAGACTTTATCCTCATCGTTGCCAGAATCTGCCGACA
TAGCAGAATCGGCATCACTAGGCAACGTAGAGGTAGGAACGGCGCTCCAGTTCCGCTGCCCCCAAAATCTCCTTC
GACCCCATTTCCATTCACTATTGCGCTCCCGCTGGCTTCGCTATCCTCAAGTGTAAAGATAAGAACTTCAATGGCG
AAGAGGATTGGCATCTGGGACAGGGAGTGTCCATCGAATGGAGACAGAAAAGCTATAGCACACAGGTGGACCCCTGA
CCTCGCCGATCAGCCTAGCCTCTATCCTCCCTTAGCTTCCCTGAAAAGCCTCTTCGGAACGATCCCTTATCCCAA
GCCGCTAGAAGGGCTATCCTCGGCCATATAGTCAGGAGAAGGTGTGAGTATCAGTCCGGACACAATAAGGTGGCT
CCCTGCAATACCTCGCACTCAGTCAACCCACAACCGCTTGCTACAAGTGTTACTGTAAGAAATGTTGCTTCCACTG
TCAGGTCTGCTTCTGAAGAAGGGACTGGGAATCAGGGATTACGGAAAGCAAATGGCTGGCGATGACTGTGTGGCC
AGCAGGCAAGACGAAGACGAGCAAGTACCATAGCAATTGGAGAACCATGGCAATGAGTTTAACCTCCCCCTA
TCGTCCCTAAGGAAATCGTCGCAATTGCAATAAGTGTAACGAATGGACACTGGAATGCTGGAGGAACTGAAACA
TGAAGCCGTGAGACACTTTCCAGACCCCTGGCTGCATGGCCTCGGTCAACACGATATCATTAGCCTCTGGGATCAG

Figure 30 (Cont)

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TCCCTGAAACCTGTGTGAACTGACACCCCTCTGCGTCACCCCTCAACTGTACCAATGCCAATCTGATGAAGAGAT
ACTCCACCCAAGTGACCCCGATCTGGCTGACCAACTGATTACCTCCACTATTTGATTGCTTTGCCGATAGCGC
AATCCATCCCATCGGCCAACACGGAATGGAGGATGAGGATAGGGAAGTGCTGAAATGGAAATTCGATAGCCATCTG
GCTCTCAGGCATATCGCTTCTAGTCCTATCGATACCGTCCCCGTCAAGCTCAAGCCTGGCATGGACGGACCCAAAG
TGAAACACTGGCCCCCTACCGAAGAGAAAAATCAAAGCCATTTGGCCTAGCAACAAGGGAAGGCCTGGCAATTTCCC
GCAGTCCAGGCCTGAGCCTACCGCACCCCCAGCCGAGAGCTTTAGATTCCGCATTAGCAAAAAGGCTAAGGGATGG
TTTTACAGACACCATTACGATAGCCGACACCCTAAGGTCAGCTCCGAGGTCCACATTCCCCTCGGCATGATGACCG
CTTGCCAAGGCGTCGGCGGACCCAGTCACAAAGCCAGGGTACTGGCAGAGGCTATATCCAGGTGAACAACGCTAA
CATTCTCCCCATTGTGGCCAAAGAGATTGTGGCAAATGTGACAAATGCCAGCTCAAGAGTGAGGCTATTACCGGA
CAGGTGAAGTGTAGCCCTTCCGAGGGAAACAAGACAGACTAGGAAGAACAGACGTAGAAGGTGGCGTGCGAGGCAAA
GGCAAATCCACTCCATCTCCGAGAGGATTCTGGGACAGATGAGGGAACCCAGAGGCTCCGACATTGCCGTAATAC
AAGCACACTGCAAGAGCAAATCGCATGATGACAAGCAATCCCCCTAGCATTCAACAAGAGTTTGGCATTCCCTAT
AACCCTCAGTCCCAGGGCGTCGTGGAAAGCATGAACAAAGAGCTAAAGAAAATCATTGGCAGACAGGAGATCCTCG
ATCTCTGGGTCTACCATAACCAAGGCTATTTCCCTGACTGGCAGAAATTACACACCCGGACCCGGAGTCAGATACCC
TAGCAGAGAAAGACAGAGACAGATTCTATTCTATTAACGAATGGATTCTCAGCAACTGCCTCGGCAGATCCGCTGAG
CCTGTGCCTCTGCAACTGTATAAGACACTGAGAGCCGAACAGGCTACCCAAGAGGTCAAGAATTGGATGACCGAGA
CACTGCTCGTGCAAAACGCTAACCCCTGACTGTGAGAGAGTGTATCTGGCTTGGGTCCCCGCTCATAAAGGCATTGG
CGGAAACGAACAGGTGGACAAACTGGTCAGCGCTGGCATTAGGAAAACAGACCCTAACCCCTCAGGAAATCCATCTG
GAAAACGTACCGAGAACTTTAATGTGTGAAAAACGATATGGTGGAGCAAATGCATGAGGCTGGCTATGCCATTCT
TGAAATGCAATAACAAAAGGTTCAACGGAACCTGGACCCAGTAAGAATGTGTCCACCGTCCAGTGTACCCATGGCCT
AGAGCTCAAGAATAGCGCTATCTCCCTGCTCAACGCTACCGCTATCGCTGTGGCTGGGTGGACCGATAGGGTTATC
GAAGTGGTTTCAGTCCCGGCATCCCAAAGTGTCCAGCGAAGTGATATCCCTCTGGGAGACGCTAGGCTCATCATT
GGACATACTGGGGCTCCACACAGGCGCTGCTATGGGCGGTAAATGGTCCAAGTGCTCCCTCGTCGGATGGCCCCG
AGTGAGAGAGAGAATCAGACAGACACCCCTGCCGCTGAGGGAGTGCTCAAGACCGGCAAGTACTCTAGGAAGAGG
GGTGCCCATACCAATGACGTCAAGCAACTGACAGAGGCTGTGCAAAAGATTGCCACAGAGTCTAGCTGGGAGGGTC
TGAAATACTGGGGGAATCTGCTCCAGTACTGGGGCCAGGAAC TGAAATCTCCGCCGTCAGCCTCCTGAATGCCAC
AGCCATTGAGCTGCCTGAGAAAGAAAGCTGGACCGTCAACGATATCCAAAAGCTCGTGGGAAAGCTCAACTGGGCA
TCCCAGATTTACCCCGGAAGAGCCATTGAGGCTCAGCAACACATGCTGCAACTGACAGTGTGGGGCATTAAAGCAAC
TGCAAGCCAGAGTGCTCGCCATTGAGAGATACCTCGCCCTCCAGGATAGCGGATTGGAAGTGAATATCGTCACCGA
TAGCCAATACGCTCTAGGCATCATTGAGGCTCAGCCTGACAAAAGCGAAAGGGAAATCTCCAACTATACCAATCAG
ATTTACAAGATCCTCACCGAATCTCAAAATCAACAGGATAGGAATGAGAAAGACCTCCTGGCTCCCACAAAGGCTA
AGAGAAGGGTCGTGCAAAGGGAAAAGCGTGCCGTCGGCATTGGCGCTATGTTTCTCGGATTCTCGGCGCTGCCAA
ACCCAAAATGATCGGAGGCATTGAGGCTTTATCAAAGTCAGGCAGTATGACCAAATCCTTATCGAAATCTGTGGA
AACAAGGCTATCTCCTACCATAGGCTCAGGGATTTATTCTGATCGTCGCTAGGATTGTGGAAGTCTCGGCCGTA
GCTCCCTGAAAGGCCCTCAGAGAGGCACACTGAATGCCTGGGTGAAAGTGATTGAGGAAAAGGGATTGAGTCCCGA
AGTGATTCCCATGTTTTCCGCTCTGTCCGAGGGAGCCACACTCGAGtgaagatctgaattc

Figure 30 (Cont)

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B2 fragment

ggatccaccATGCTCGAGAATATGCTCACCCAAATCGGATGCACACTGAATTTCCCTATCTCCCCATTGACACAG
TGCCCTGTGAACTGAAACCCGGAATGGATGGCGCCGCCATCTTTAGGCCTGGCGGAGGCAATATGAAAGACAATTG
GAGAAGCGAACTGTATAAGTATAAGGTCGTGAAGATTAAGCCTCTGGGAATCACATGGATTCCCGAATGGGAGTTC
GTCAACACACCCCCACTGGTCAAGCTATGGTATCAGCTGGAGAAAGAGCCTATCGTTGGCGCTGAGCCTCAGGATC
TCAACACGATGCCGAATACTGTAGGAGGCCATCAGGCTGCTATGCAAATGCTGAAAGACACAATCAATGAGGAAGC
CGCTGTCTGTCTTCTGGATGGCATTAAACAAAGCTCAAGAGGAACATGAGAAGTATCACTCCAATGGAGGACAATG
GCCAACGACTTTAATCTGATGAAGCATCTCGTCTGGGCTCTAGGGAGCTGGAGAGATTCTGCTCTGAATCCCGGCC
TGCTGGAGACATCCGAAGGCTGTAAAGCAAATTGCTGAGGAAGAGATTATCATTAGGTCCGAGAATTTCAAAACAA
TGTCAAAACCATTTATCGTCCACCTCAACGAAAGCGTCGAGATTAAATGGGCGCTAGGGCAAGTGTCTCAGCGGC
GGCAAGCTGGACGCTGGGAAAAGATTAGGCTCAGGCTGGCGCAAGAAAAAGTATAGGCTCAAGGAGAAGGGAG
GCCTGGACGGAATGATTTACTCCCAAAGAGGCAAGACATTCTGGATCTGTGGGTGTATAACACACAGGGATTAC
TAGATGGGGAACCTTGATCCTCGGCTTGGTGATTATCTGTAGCGCCAGCGAGAATCTGTGGGTGACAGTGTATTAC
GGAGTGCCCTGTGTGGAGGAGACAGCTCCTGTCCGGCATTGTGCAACAGCAAAATAACCTCCTGAGGGCTATCGAAG
CCCAACAGCATCTGCTCCAGCTCACCGTCTGGGTGAGGCATTTCCCAGGCCCTTGGCTCCACAGCCTGGGACAGTA
CATCTATGAGACATACGGAGACACATGGTGGGAGTGGAGCCCTCAAAGCCCTCATCAAACCCAAAAGATTAAAG
CCTCCCTCCCATCCGTGAAAAAGCTCACCGAAGACAAATGGAATAAGCCTCAAAGACATATAGCGCTGGCGAAA
GGATTGTGATATCATTGCAACCGACATTCAGACTAAGGAACTGCAAAACCAAATCATAAAGATTGAGAAATTCGC
TGTGTTTATCCATAACTTTAAGAGGAAGGGAGGCATTGGCGGCTACTCCGCGGAGAGAGAATCATTGACATTATC
GCCAGCGATATCGTTCCCGTGGGCGATATCTATAAGAGATGGATCATTCTGGGACTCAACAAAATCGTGAGAATGT
ATTCACCCGTGAGCATTCTGGATATCAGAGTGAGACAGGATACTCCCCCTCAGCTTTCAGACACTGATGCCCGC
TCCAGAGGCCCTGACAGACTCGAACGCATTGAGGAAGAGTCCAGGAGGACCATCAGTATCCCATTTCCGAACAG
CCTCTGTCTCAGACAAGGGGAGACAATCCCAAGACCCTAAGGAAAGCAAAAAGGCTAGTGGAGTGGTTCGAGTCCA
TGAATAAGGAACTGAAAAAGATTATCGGACAGGTGAGGACAGGCTGAGCACCTGAAAAACCGCTGTGCAAAATGGC
TGCCATGACAGATGCTCAAGGATACCATTAACGAAGAGGCTGCCGAGTGGGACAGAATCCATCCCGTCCATGCCGGA
CCCATTGCCCCCTCTACCGAGATTGTAAAGAAATGAAAAAGAGGCAAAATCTCCAGGATTGGCCCTGAGAATC
CCTATAACACACCCGCTTTTGCCATTCAAGTGAGAGACCAAGCCGAACACCTCAAGACAGCCGTCAGATGGCAGT
CTTCATTACAAATTTCAAAAGGAAAGGCGGAATCGGAGGCAAAAAGAAAGATAGCACAAAGTGGAGGAAACTGGTT
GACTTTAGGGAGCTCAACAAACGTACACAGGATTTCTGGGAGGTCCAGCTCGGCTTTTCGGCTCTGGCTTGGGATG
ACCTCAGGAGCCTGTGTCTGTTTCAGCTATCACAGACTGAGAGACTTTATCCTCATCGTTGCCAGAACCTGCCGACA
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GACCCCATTTCCCATTTCACTATTGCGCTCCCGCTGGCTTCGCTATCCTCAAGTGTAACAATAAGACATTCAATGGCG
AAAAGGATTGGCATCTGGGACAGGGAGTGTCCATCGAATGGAGAAAAGAAAGCTATAGCACACAGGTGGACCCCTGA
CCTCGCCGATCAGCCTAGCCTCTATCCTCCCTTAGCTTCCCTGAAAAGCCTCTTCGGAAACGATCCCTCATCCCAA
GCCGCTAGAAGGGCTATCCTCGGCCAAATAGTCAGGAGAAGGTGTGAGTATCAGTCCGGACACAATAAGGTCCGCT
CCCTGCAATACCTTGCACTCAGCCAACCCAAAACCGCTTGCTACAAGTGTACTGTAAAGAAATGTTGCTACCACTG
TCAGGTCTGCTTCTGAAGAAGGACTGGGAATCAGGGATTACGGAAAGCAAATCGCTGGCGCTGACTGTGTGCC
AGCAGGCAAGACGAAGACGCAGCCAAGTACCATAGCAATTGGAGAACCATGGCCAGTGAGTTTAACCTCCCCCTA
TCGTGCTAAGGAAATCGTCGCAAGTTGTGATAAGTGTAACGAATGGACACTGGAACTGCTGGAGGAACTGAAACA
TGAAGCCGTGAGACACTTTCCAGACCCTGGCTGCATGGCTCGGTCAACACGATATCATTAGCCTCTGGGATCAG

Figure 30 (Cont)

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TCCCTGAAACCCTGTGTGAAACTGACACCCCTCTGCGTCAACCTCAACTGTACCAATGCCAATCTGCTGAAGAGCT
ACTCCACCCAAGTGGACCCCGATCTGGCTGACCATCTGATTACCTCCACTATTTTCGATTGCTTTTCCGATAGCGC
AATCCATCCCATGGGCCTACACGGAATGGAGGATGAGGAAAGGGAAGTGCTGAAATGGAAATTCGATAGCCATCTG
GCTCTCAGGCATATCGCTTCTAGTCCTATCGATACCGTCCCCGTCAAGCTCAAGCCTGGCATGGACGGACCCAAAG
TGAAACAGTGGCCCTCACCGAAGAGAAAATCAAAGCCATTTGGCCTAGCAACAAGGGAGGGCCTGGCAATTTCTT
GCAGTCCAGGCGCTGAGCCTACCGCACCCCGAGCCGAGAATTTAGATTTCGGCATTAGCAAAAAGGCTAAGGGATGG
TTTACAGACACCATTACGAAAGCCAAACACCCTAAGGTGAGTCCGAGGTCCACATTTCCCTCAGCATGATGACCG
CTTGCCAAGGCGTCGGCGGACCCAGTCACAAAGCCAGGGTACTGGCAGAGGCTATGTCCCAGGTGAACAACGCTAA
CATTCCTCCCATTGTGCCCCAAGAGATTGTGGCAAATGTGACAAATGCCAGCTCAAGGGTGAGGCTATGCACGGA
CAGGTGGACTGTAGCCCTTCCGAGGGATCAAGACAGGCTAGGAAGAACAGACGTAGAAGGTGGCGTGAGAGGCAAA
GGCAAATCCGCGCCATCTCCGAGTGGATTCTGGGACAGATAAGGGAACCCAGAGGCTCCGACATTGCCGGTACCAC
AAGCACACTGCAAGAGCAAATCGCATGGATGACAAACAATCCCCCTGGCATTAAAGCAAGAGTTTGGCATTCCCTAT
AACCCTCAGTCCAGGGCGTCGTGGAAGCATGAACAAAGAGCTCAAGAAAATCATTGGCAGACAGGAGATCCTCG
ATCTCTGGGTCTACAATACCCAAGGCTTTTTCCTGACTGGCAGAATTACACACCCGGACCCGGAATCAGATACCC
TAGCAGAGCAAGACAGAGACAGATTCTATGCTATTAGCGAAAGGATTCTCAGCAACTTCTCGGCAGACCCGCTGAG
CCTGTGCCTCTGCAACTGTATAAGACACTGAGAGCCGAACAGGCTACCCAAGAGGTCAAGAATTGGATGACCGACA
CACTGCTCGTGCAAAACGCAAAACCTGACTGTGAGAAAGTGTATCTGGCTTGGGTCCCCGCTCATAAAGGCATTGG
CGGAAACGAACAGGTGGACAACTGGTCAGCGCTGGCATTAGGAAAACAGACCCTAACCCCTCAGGAAATCGATCTG
GAAAACGTCAACGAGAACTTTAATCATGTGGAAAAACAATATGGTGGAGCAAATGCAAGAGGCTGGCTATGCCATTC
TGAAATGCAATAACAAAAGTTCAACGGAACCTGGACCCTGTAAGAATGTGTCCACCGTCCAGTGTACCCATGGCCT
AGAGCTCAAGAAATAGCGTGTCTCCCTGCTCAACGCTACCGCTATCGCTGTGGCTGAGTGGACCGATAGGGTTATC
GAAGTGGTTCAGTCCCAGCATCCCAAAGTGTCCAGCGAAGTGCATATCCCTCTGGGAGACGCTAGGCTCGTCATTA
AGACATACTGGGGCCTCCACACAGGCGCTGCTATGGGCGGTAAATGGTCCAAGTGCTCCCTCGTCGGATGGCCCCG
AGTGAGAGAGAGAATCAGACAGACACCCCTGCCGCTGAGGGAGTGCTCAAGACCGCAAGTACTCCAGGATGAGG
AGTGCCCATACCAATGACGTCAAGCAACTGACAGAGGTTGTGCAAAAGATTGCCACAGAGTCTAGCTGGGAGGGTC
TGAAATACTGTGGAATCTGCTCCTGTACTGGGGCCTGGAACCTGAAAACTCCGCCGTGAGCCTCCTGAATGCCAC
AGCCATTGTGCTGCCTGAGAAAGAAGGCTGGACCGTCAACGATATCCAAAAGCTCGTGGGAAAGCTCAACTGGGCA
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TGCAAGCCAGAGTGCTCGCCATTGAGAGATACCTCGCCCTCCAGGATAGCGGATCGGAAGTGAATATCGTCACCGA
TAGCCAATACGCTCTAGGCATCATTCAGGCTCAGCCTGACAAAAGCGAAAGGGAAATCTCCAACATATACCAATCAG
ATTTACAAGATCCTCACCGAATCTCAAAATCAACAGGATAGGAATGAGCAAGAACTCCTGGCTCCCAAAAGGCTA
AGAGAAGGGTCGTGCAAGGGGAAAGCGTGCCGTGGCATTTGGCGCTATGTTTTTCGGATTCTCGGCGCTGCCAA
ACCCAAAATGATCGGAGGCATTGGAGGCTTTATCAAAGTCAGGCAGTATGACCAAATCCTTATCGAAATCTGTGGA
CAGAAGGCTATCTCTACCATAGGCTCAGGGATTTCATTCTGATCGTCGCTAGGATTGTGGAACCTGCTCGGCCATA
GCTCCCTGAGAGGCTCCGAGAGGCACACTGAATGCCTGGGTGAAAGTGGTTGAGGAAAAGGGATTCAATCCCGA
AGTGATTCCCATGTTTACCGCTCTGTCCGAGGGAGCCCACTCGAGTgaagatctgaattc

Figure 30 (Cont)

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C1 fragment

ggatccaccATGCTCGAGAGCAACACACCCGCTAATAATGCCGATTGCGCGTGGCTGAAAGCCCAGGAAGAGGAAG
AAGTGGGATTTCCTGTGAGACCCCAAGTGCTAGAGCTTGGAGGGCTATCCTCAACATTCCCAGGAGGATTAGGCA
AGGCTTTGAGAGAGCCCTCCTAGCCGCCGAATGGGACAGGGTTACCCCTGTGCACGCTGGCCCTGTGCTCCCGC
CAAATGAGAGAGCCCAGAGGAAGCGATATCGCTGGCACAACCCCTCAGGCCCATGACATATAAGGCCGCTATTGACC
TCAGCTTGTTTTCTGAAAGAGAAAGGCGGACTGGAAGGCCTCATCTATAGCAAGAAAGCTGCTATGGAAACAGGCTCC
CGAAGACCAAAGCCCTCAGAGAGAGCCTTACAATGAGTGGACCCCTGGAGCTCCTGGAAGAGCTCAAGAAAGAGGCT
CAAGGCCAATGGACCTACCAAATCTTTAGGAACCCCTTAAAGAACTGAAAACCGAAAGTATTCCAGAATGAGAA
GCGCTCACACAACTGGATGACAGAAACCCCTCTGGTCCAGAAATGCCAATCCCGATTGCAAGTCCATCCTCAGGCTC
TCTGGGAACCGGAGCCACACTGGAAGAGCCTGAGGTCATCCCTATGTTCTCAGCCCTCAGCGAAGGCGCTACCCCC
CAAGACCTGAATACGATGCTCAACATCGTCAGCGGACACCAATCCACCTCCAGGAACAGATTGGCTGGATGACAA
ATAACCTCCCATCCCTGTGCGAGAGATTTACAAAAGGTGGATTATCCTCGGCTGACTAGAATCCCCCATCCCGC
CGGCTCAAGAAAAGAAAAGCGTCACCGTCTGGATGTGGGAGACGCTTACTTCAGCGTCCCCCTCGACGAAGAC
CAAAAGGAAACCTGGGAGGCTTGGTGGACGGAATACTGGCAGGCTACCTGGATTCTTGAGTGGGAGTTTGTGAATA
CCCCTCCCCCTCGTGTTCCTCGATTGGCATAACTATACCCCTGGCCCTGGCATAAGGTATCCCCTCACCTTTGGATG
GTGCTTTAAGCTCGTGCTGTGGACCCCAACTGTGGTACCAACTGGAAGGAACCCATTGTGCGAGCCGAAACC
TTTTACGTGGACGGAGCCGCCAACAGAGAGACAAAGCTCGGCCAAAACGTCCAGGGACAGATGGTGCATCAGGCTA
TTAGCCCCAGGACCCCTCAACGCTTGGGTCAAGGTCGTGGAAGAGAAAGCCTTTAACGAAACCGAAGTGCATAACGT
CTGGGCTACCCATGCCTGTGTGCGTACCGATCCCAATCCCCAAGAGATTCTCCTGGAGAATGTGACAGAGCTCAAG
GATCAGAACTCCTCGGCATTGGGGATGTCCGGCAAAATCATTGACAACTGTGCCTTGAACAGCTCCT
GGTCCAACCAAGCTGGCCATAACAAAGTGGGAAGCCTCCAGTATCTGGCTCTGACGGCTCTGATTAAGCTAAGAA
AATCAAAACCCCTCTGCCTAGCGTTAAGACAATCATTGTGCATCTGAATGAGTCCGTGGAAATCAATTGCACAAGG
CCTAACATAACACAAGGAAAGCCGCCCTAGTGAAGTACGGAATAAGTCCAAACAGAAAACCCAGCAAGCTGCCG
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CGCTTGTGGTGGGCAATATCAAACAGGAGTTTGAATCCCTTACAATCCCCAAGCCAAACATTCTATGTGGAT
GGCGCTGCCAATAGGGAACCCCAACTGGGAAAGGCGGCTATGTGACAGACAAAGGCAGACAGAAAGTCATTAGCG
GAATCTGGCAGCTCGACTGTACCCATCTGGAAGGCAAAGTCATTCTGGTAGCCGTCCACGTGCGCTCCGGCTACAT
TGAGGCTGAGGTGCGCAATGAGCAAGTGGATAAGCTCGTGAGTTCCGGAATCAGAAAGGTGCTATTCTCGACCGA
ATCAATAAGGCTCAGGAAGAGCACGAAGTCAGGGAAGGATTAGGCGAACCGCTCCCGCTGCTGAAGGCGTCCGCG
CTGTCTCCAGGATCTGGATAAGTACGGAGCCCTCACCTCCACAAGCGGAACCCAACAGTCCAGGGAACTGAAAC
TGGCGTCCGCAACCCCTCAGATTTTGGGAGAGTCCACGTTGTCTCGGCTCCGGCTCCATCGTCACTGCGGGTAAA
ACCCCTAAGTTTAAAGTTCCCATTCAGAAAGAGACATGGGAAGCCTGGTGGACGGAGTATTGGCAAGCCGCTGCTT
ACAGACTGATCAGCTGTAAACACAAGCGTTATCAAACAGGCTTGCCCTAAGATTACCTTTGACCTATCCCTATCCA
TTACTGTGCCCCCTCCTAGCTGGATGGGCTATGAGCTCCACCCTGACAGATGGACAGTGCAACCCATCGTGCTCCCC
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CATTTGGAAAGGCCCTGCCAACTGCTCTGGAAGGCGAAGGCGCTGTGGTCATCCAAGACATTAAGATTGGAGGC
CAACTGATAGAAGCCCTCCTGGATACAGGAGCCGATGACACCGTCTGGAAGATATGAATCTGCCTGGCAAGTGGG
GAATCAAACAGCTCCAGGCTAGGGTCTGGCTATCGAGAGGTATCTGAAAGATCAACAGTTTCTGGGACTCTGGGG
CTGTAGCGGAAAGGCTGCTATGGAAAACAGATGGCAAGTGATGATCGTCTGGCAAGTGGACAGGATGAAGATTAGG

Figure 30 (Cont)

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ACATGGAATAGCCTCGTGAAACACCATATGTATATTATCTGTACCACAACCGTCCCCTGGAAGTCCACCTGGAGCA
ATAAGTCCTTCGAAGAGATTTGGAATAACATGACCTGGATTCAATGGCTGATTCTCGCTATCGTCGTGTGGACCAT
TGTGTATATCGAATACAAGAACTGCTCAGGCAAAGGAGAATCGATAGGCTCATCAAAGGCTCAACCTTGGCCTC
CTGGAAACCGCTGAGGGATGTAAACAGATCCTGGAACAGCTCCAGCCCGCCCTCCAGACAGGCACCGAAGAGCTCT
CTAGTAGAAAGCTCCTGAAACAGAGAAAGATTGACAGACTGATTGAGAGAATCAGAGAGAGAGCCGAAGACTCCGG
CAATGAGTCCGAGGGAGACACACCCGAATCAGATACCAATACAATGTGCTCCCCAAGGCTGGAAGGGCTCCCCA
CCCATTTTCAAAGCTCCATGACCCAAATCCTCATGATGCAAAGGGGAACTTTAAGGGACAGAAAAGGATTATCA
AGTGCTTCAACTGTGGAAGGAAGGCCATCTCGCTAGGAATTGACAGACCTCCCCTAGAGAGACTGAACCTGGATTG
CTCCGAGGATAGCGACACCTCCGGCACACAGCAAAGCCAAGGCACAGAGACAGAAGTGGGACTCGTGGCTGTGCAT
GTGGCCAGCGGATATATCGAAGCCGAAGTGATCCCTGCCGAACTGGACAGGAAACCGCTTACTTTATCCTCAAGA
TTAAGCCTGTGGTCAGCACACAGCTCCTGCTCAACGGTAGCCTCGCTGAAGAGGAAATCATTATCAGAAGCGAAAA
CTTTACCGATAACAACTGGTCGGCAAACCTGAATTGGGCTTCCCAAATCTACGCTGGCATCAAAGTGAAGCAACTG
TGTAAGCTCCTGAGAGGCACCAAAGCCCTCACTCCTCTGTGTGTGACACTGAATTGCACAAACGCTAACCTCATCA
ATGTGAATGCTGCTCAAACAGAGGCGATAACCTACCGGTCCCGAAGAGTCCAAGAAAGAGGTGCGCGTCCAAGAC
AGAGACAGACCCCTGTGACGCCGCCCTAGCTCCAACCTTCTGGAAGGTCTGCCGAACCCGTCCTCCAGCCC
CCCCCTCTGGAAGGCTCCACCTCGACTGTAGCGAAGACTGTGGCGAACTGGATAAGTGGGCTCCTGTGGAAGT
GGTTCAATATCACCACTGGCTGTGGTACATTAAGATTTTCATTATGATTGTGGGAGGCAATAAGATTGTGAGGAT
GTACTCACCTGTCTCCATCCTCGACATTAAGCAAGGCCCTAAGGAACCTTCAGGGATTACGTGGACAGATTGCGT
AAGCTCCTGTGGAAGGGAGAGGGAGCCGTCGTGATTACAGGACAACCTCCGACATTAAGGTCGTGCCAGGAGAAAGG
CTAAGATTATCGAACTGAATAAGAGAACCCAAGACTTTTGTGAAGTGCAACTGGGAATCCCTCACCCTGTGGACT
GAAGAAGAAAAAGTCAGTGACAGTGGCCGCTATGAGAGTGAAAGAGACACAGATGAACTGGCCCAATCTGTGGAAG
TGGGGACAATGATTCTGGGACTGGTCATCATTGTCTCCGCTCCATTAAAGGTCAGACAGCTCTGCAAACCTGCTCA
GGGTACAAAGGCTCTGACAGAGATTGTGACACTGACAGAGGAAGCCGAACTGGAAGTCTCATATGGAAGTTTGA
CTCCCGCTCGCCCTGAGACATATCGCCAGGGAAGTGCATCCCGAGTTCTACAAAGACTGCGCTGTGTGAGCTC
CTGGGACGCTCCAGCCTCAAGGGACTGCAAAGGGGATGGGAAGGCCTCAAGTATTTGTGGAACCTCCTGCAGTATT
GGGGCTCTAGCCTGGGGCAACTGCAACCTGCTCTGAAAACCGGATCAGAGGAAGTGAAGTCCCTGTATAACACAAT
CGCTACCTCTGGTGTGTGCATCAGGAGCTCTACAAATACAAAGTGGTCAAAATCAAACCCCTCGGCATTGCCCT
ACCAGAGCCAAAAGGAGAGTGGTCGAGAGAGAGAAAAGGCTCACCGAAATCGTCCCCTCACCAGAGAGGCTGAGC
TGGAGCTGGAGGAAAACAGAGAGATTCTGAGGGAACCCGTCCACGGAGTGTATAGAGTGTCTGCCGAAGCCATGAG
CCAAGTCAACAATGCCAACATCATGATGCAGAGAGGCAATTTCAAAGGCCTAAAGAGAATCATCAAACAAGAGGAA
GAGGAGGTCCGGCTTCCCCGTAGGCCCCAGGTCCCCTGAGACCTATGACCTACAAAGGAGCCGTGATCTGTCTCT
TCTTCAGACAGGGACCCAAAGAGCCTTTAGAGACTATGTGGATAGGTTTTTCAAACCCCTCAGGGCTGAGCAAGC
CTCAGGAAGTGAAAACTGGGAGAAAATCAGACTGAGACCTGGTGGCAAAAAGAAAATACAAATGAAACACATT
GTGTGGGCCTCCAGGGAAGTGAAGGTTTGCCTCCAGTATGCCCTCGGCATCATCCTAGCCCAACCCGATAAGT
CCGAGTCCGAGCTCGTGAATCAGATTATCGAAGAGCTCATCAAGAAGATTGCCGTCCCGGATGGACAGACAGAAT
CATTGAGGTGACCAAAGGGCTTGGAGAGCCATTCTGAATATCCCCAGGAGAATCAGACAGACTAGACTCGCCGGA
AGGTGGCCCGTCAGGACAATCTATACCGATAACGGAAGCAATTTACAAGCGCTACCGTCAAGGCTGCCTGTGGT
GGGCTGATGTGAACAGCTCACCGCAGTCGTCCAGAAAATCGCTACCGAAAGCATTGTGATATGGGGAAGACGCC
CAAGTTCAGACTGCCTATCGCTGCCGCCAGCAACGAGAACATGGAGACCATGGCTGCTTgaagatctgaattc

Figure 30 (Cont)

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C2 fragment

ggatccaccATGCTCGAGAGCAACACAGCCGCTAACAATACCGATTGCGTGTGGCTGAAAGCCCAGGAAGAGGAAG
AAGTGGGATTTCTGTGAGACCCCAAGTGCTAGAGCCGGGAGGGCTATCCTCAACATTTCCACGAGGATTAGGCA
AGGCCTTGAGAGAGCCCTCTAGCCGCCGAATGGGATAGGATTACCCCTGTGCACGCTGGCCCTATCGCTCCCGGC
CAAATGAGAGAGCCAGGGGAAGCGATATCGCTGGCACAACCCTCAGGCCCATGACATATAAGGCCGCTATTGACC
TCAGCTTGTCTTCTGAAAGAGAAAGGCGGACTGGATGGCCTCATCTATAGCAAGAAAGCTGCTATGGAAACAGGCTCC
CGAAGACCAAAGCTCTCAGAGAGAGCCTTACAATGAGTGGACCCTGGAGCTCCTGGAAGAGCTCAAGCACGAGGCT
CAAGGCCAATGACCTTCCAAATCTTTAGGAACCCCTTTAAGAATCTGAAAACCGGAAAGTATGCCAGAATGAGAG
GCGCTCACACAACTGGATGACAGATACCTCCTGGTCCAGAATGCCAATCCCGATTGCAAGTCCATCCTCAAGGC
TCTGGGACCCCGAGCCTCACTGGAGAGCCTGAGGTCATCCCTATGTTCTCAGCCCTCAGCGAAGGCGCTACCCCC
CAAGACCTGAATATGATGCTCAACACCGTCGGCGGACACCAATCCACCCTCCAGGAAACAGATTGGCTGGATGACAA
ATAACCTCCCATCCCTGTGCGAGAGATTTACAAAAGGTGGATTATCCTCGGCCTGACTAGAATCCCCCATCCCGC
CGGCCTCAAGAAAAGAAAAGCGTCACCGTCTGGATGTGGGAGACGCTTACTTCAGCGTCCCCCTCGACGAAGGC
CAAAGGGAACCTGGGAGGCTTGGTGGATGGAATACTGGCAGGCTACCTGGATTCTGAGGGGGAGTTTGTGAATA
CCCCTCCCCTCGTGTCTCCCGATTGGCAAACTATACCCCTGGCCCTGGCACAAGGTATCCCCTCACCTTTGGATG
GTGCTTTAAGCTCGTGCTGTGGACCCCAACTGTGGTACCACTGGAAAAGGACCCCATTTGTGCGAGTCGAAACC
TTTACGCGGACGGAGCCGCCAACAGAGAGACAAAGCTCGGCCAAAACGTCAGGGACAGATGGTGCATCAGCCTA
TTAGCCCCAGGACCTCAACGCTTGGGTCAAGGTATCGAAGAGAAAGGCTTTAGCGACACCGAAGTGCATAACGT
CTGGGCTACCCATGCCTGTGTGCCTACCGATCCCAATCCCAAGAGATTCTCCTGGAGAATGTGACAGAGCTCAAG
GATCAGAACTCCTCGGCATTGGGGATGTCCGGCAAACTCATTGACACAACCACTGTGCCTTGAACAGCTCCT
GGTCAACCCAGCTGGCCATAACAAAGTGGGAAGCCTCCAGTATCTGGCTCTGAAGGCTCTGATTACGCCTAAGAA
AATCAAAACCCCTCTGCCTAGCGTTAAGACAATCATTGTGCATCTGAATGAGTCCGTGGAAATCAATTGCACAAGG
CCTAACATAACACAAGGACAGCCGCCCTAGTGAAGTACAGAATAAGTCCAGACAGAAAACCCAGCAAGCCGCCG
CCGATACAGGCAGCTCCAGCAAGGTCAAGCAAACTATCCCATTTGTGTCCAACCTTTACCTCCACCACTGTGAAAGC
CGCTTGTGTGGTGGGCCAATATCAACAGGAGTTTGGAAATCCCTTACAATCCCAAGCCGAACATTCTATGTGGAT
GGCGCTGCCAATAGGGAACCAAACTGGGAAAGGCTGGCTATGTGACAGACAGAGGCAGACAGAAAGTCGTTAGCG
GAATCTGGCAGCTCGACTGTACCCATCTGAAAGGCAAGTCATTCTGGTAGCCGTCACGTCGCTCCGGCTACAT
TGAGGCTGAGGTCCGCAATGAGCAAGTGGATAAGCTCGTGATTTCGGGAATCAGAAAGGTGCTATTCTCTGACGGA
ATCGATAAGGCTCAGGAAGAGCACGAAGTCAGGGAAGGATTAGGCGAGCCGCTCCCGCTGCTGAAGGCGTCGGCG
CTGTCTCCAGGATCTGGATAAGTACGGAGCCATCACCTCCACAAGCGGAACCCAACAGTCCAGGGAACTGAAAC
TGGCGTCGGCAACCCCTCAGATTTTGGGAGAGTCCAGCGCTGTCTCGGCTCCGGCTCCATCGTCACTGTGGGTAAA
ACCCCTAAGTTTAAAGCTCCCATTCAGAAAGAGACATGGGAAACCTGGTGGATGGACTATTGGCAAGCCGCTGCTT
ACAGACTGATCAGCTGTAACACAAGCGTTATCACACAGGCTTGCCCTAAGATTAGCTTTGAGCCTATCCCTATCCA
TTACTGTGCCCCCTCTAGCTGGATGGGCTATGAGCTCCACCCTGACAGATGGACAGTGCAACCCATCGTGCTCCCC
GAAAAGGAGTCTGGACAGTGAATGACATTAGAAAAAATTCTGAAAGCCCTCGGCCAGGCGCTACCTGGAGG
AAAATATGACAGCATGTGAGGAGTGGGAGGCCCTGGCCATAAGGCTAGAGTGTATTACAGAGACTCCAGGGACCC
CATTTGGAAAGGCCCTGCCAACTGCTCTGGAAAGGCGAAGGCGCTGTGGTCATCCAAGACATTAAGATTGGAGGC
CAACTGAAAGAAGCCCTCTGGATACAGGAGCCGATGACACCGTCTGGAAGATATCAATCTGCCTGGCAAGTGGG
GAATCAACAGCTCCAGGCTAGGGTCTGGCTATCGAGAGGTATCTGAAAGATCAACAGCTTCTGGGAATCTGGAG
CTGTAGCGGAAAGGCTGCTATGGAAAAACAGATGGCAAGTGATGATCGTCTGGCAAGTGGACAGGATGAAGATTAGG

Figure 30 (Cont)

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ACATGGAATAGCCTCGTGAAACACCATATGTATCTTATCTGTACCACAGCCGTCCCCTGGAACCTCCACCTGGAGCA
ATAAGTCCTTCGAAGAGATTGTGAATAACATGACCTGGATTGAATGGCTGATTATCGCTATCGTCGTGTGGACCAT
TGTGTTTATCGAATACAAGAACTGCTCAGGCAAAGGAAAAATCGATAGGCTCATCGAAAGGCTCAACCCTGGCCTC
CTGGAACCGCTGAGGGATGTAAACAGATCCTGGAACAGCTCCAGCCCGCCCTCAAGGCAGGCACCGAAGAGCTCT
CTAGTAGAAAGCTCCTGAGACAGAGAAAGATTGACAGACTGATTGAGAGAATCAGAGAGAGAGCCGAAGACTCCGG
CAATGAGTCCGAGGGAGACACACCCGGAATCAGATACCAATACAATGTGCTCCCCAAGGCTGGAAGGGCTCCCCA
GCCATTTTCAAAGCTCCATGACCAAAATCCTCATGATGCAAAGGGGAACTTTAAGGGACAGAAAAGGATTATCA
AGTGCTTCAACTGTGGAAGGAAGGCCATCTCGCTAGGAATGCGAGACTCCCCTGGAGAGACTGAACCTGGATTG
CTCCGAGGATAGCGACACCTCCGGCACACAGCAAAGCCAAGGCACAGAGACAGGAGTGGGACTCGTGGCTGTGCAT
GTGGCCAGCGGATATATCGAAGCCGAAGTGATCCCTGCCGAACTGGACAGGAAACCGTTACTTTCTCCTCAAGA
TTAAGCCTGTGGTCAGCACACAGCTCCTGCTCAACGGTAGCCTCGCTGAAGAGGAAATCATTATCAGAAGCGAAAA
CTTTACCAATAACAACTGGTCGGCAAACCTGAATTGGGCTTCCCAAATCTACCCTGGCATCAAAGTGAGGCAACTG
TGTAAGCTCCTGAGAGGCACCAAAGCCCTCACCCCTCTGTGTGTGACACTGAATTGCACAAACGCTAACCTCATCA
ATGTGAATGTGCTCAACCCAGAGGCGATAACCTACCGATCCCAAAGAGTCTAAGAAAGAGGTGCGCTCCAAGGC
AGAGACAGACCCTTTTGACGCGCGCCCTAGCTCCACCTTTCTGGGAAGGTCTGTGCAACCCGTCCCCCTCCAGCTC
CCCCCTCTGGAAGGCTCCACCTCGACTGTAGCGAAGACAGTGACGAAGTGGATAAGTGGGCTCCCTGTGGAAGT
GGTTCAATATACCAACTGGCTGTGGTACATTAAAGATTTTATTATGATTGTGGGAGGCAATAAGATTGTCAGGAT
GTACCAACCTGTCTCCATCCTCGACATTAAGCAAGGCCCTAAGGAACCTTCAGGGATTACGTGGACAGATTGCT
AAGCTCCTGTGGAAGGGAGAGGGAGCCGTGCTGATTTCAGGACAACTCCGACATTAAGGTGCTGCCAGGAGAAAG
CTAAGATTATCGAACTGAATAAGAGAAACCAAGACTTTTGGAAGCGCAACTGGGAATCCCTCACCATGCTGGACT
GAAAAAGAAAAAGTCCGTGACAGTGGCCGCTATGAGAGTGAAAGAGACACAGATGAACTGGCCCAATCTGTGGAAG
TGGGGCACAATGATTCTGGGACTGGTCATCATTTGCTCCGCTCCATTAAGGTCAAACAGCTCTGCAAACTGCTCA
GGGGTGCAAAGGCTCTGATAGACATTGTGCCACTGACAGAGGAAGCCGAAGTGGAACTGCTCATATGGAAGTTTGA
CTCCACCTCGCCCTGAGACATATCGCCAGGGAAGTGCATCCCGAGTACTACAAAGACTGGCTGTGTGAGCTC
CTGGGACGCTCCAGCCTCAAGGAAGTGCAGAGGGGATGGGAAGCCCTCAAGTATTTGTGGAACCTCCTGCAGTATT
GGGGCTCTAGCCTGGAGCAACTGCAATCTGCTCTGAAAACCGGATCAGAGGAAGTGAAGTCCCTGTTTAAACAGT
CGCTACCTCTGGTGTGTGCATCAGGAGCTCTACAAATACAAAGTGGTCAAATCGAACCCTCGGCATTGCCCT
ACCAAAGCCAAAAGGAGAGTGGTCCAGAGAGAGAAAAGGCTCACCGATATCGTCACACTCACCGAAGAGGCTGAGC
TGGAGCTGGAGGAAAACAGAGAGATTCTGAAGGAACCCGTCCACGGAGTGATAGAGTGCTCGCCGAAGCCATGAG
CCAAGCCAACATGCCAACATCATGATGCAGAGAGGCAATTTTCAGAGGCCCCAAGAGAAATCATCAAAACAGAGGAA
GAGGGGCTCGGCTTCCCCGTCAGGCCTCAGGTCCCACTGAGACCTATGACCTACAAAGCAGCCATCGATCTGTCTT
TCTTCAAACAGGGACCCAAAGAGCCTTTTCAGAGACTATGTGGATAGGTTTTTCAAACCCCTCAGGGCTGAGCAAGC
CTCACAGGAAGTGAAAACTGGGAGAAAATCAGACTGAGATCTGGTGGCAAAAAGAAATACAACTGAAACACATT
GTGTGGGCTCCAGGGAAGTGGAAAGGTTTGCTCCCACTATGCCCTCGGCATCATCCTAGCCCAACCCGATAAGT
CCGAGTCCGAGCTCGTGAGTCAGATTATCGAAGAGCTCATCAAGAAGATTGCCGTGCGCGGATGGACAGACAGAGT
CATTGAGGTGCTCAAAGGGCTTGGAGAGCCATTCTGAATATCCCCAGGAGAATCAGACAGACTAGACTCGCCGA
AGGTGGCCCGTCAAGATAATCCATACCGATAACGGAAGCAATTTACAAGCACTGCCGTCAAGGCTGCCTGTGCT
GGGCTGATGTGAAACAGCTCACCGAAGTCGTTAGAAAATCGCTACCGAAAGCATTGTGATATGGGGAAGACACC
CAAGTTCAGACAGCCTATCGCTGCCGCCAGCAACGAGAACATGGACGCCATGGCTGCTTgaagatctgaattc

Figure 30 (Cont)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU01/00622

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl. ⁷ : C07K 19/00; C12Q 1/68; C07K 2/00, 14/005, 14/15, 14/20, 14/435; C12N 15/09		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) SEE ELECTRONIC DATABASES BELOW		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched SEE ELECTRONIC DATABASES BELOW		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CA WPIDS MEDLINE: Combinatorial protein/peptide/polypeptide; gene/DNA shuffling; domain swapping; vaccine; synthetic protein/peptide polypeptide		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00/18906 A. MAXYGEN INC. 6/4/00	All
X	WO 99/41402 A. MAXYGEN INC. 19/8/99	All
X	WO 99/41369 A. MAXYGEN INC. 19/8/99	All
X	WO 99/41368 A. MAXYGEN INC. 19/8/99	All
X	Ryu DDY and Nam D-H. Recent progress in biotechnological engineering. Biotechnol Prog. Jan-Feb 2000. 16: 2-16.	All
X	Purmonen J. Molecular breeding of allergy vaccines and antiallergic cytokines. Int Arch Allergy Immunol. March 2000. 121: 173-182	All
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* "A" "E" "L" "O" "P"	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 1/8/01	Date of mailing of the international search report 7 August 2001	
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized officer Gillian Allen Telephone No : (02) 6283 2266	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU01/00622

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Coward E. Shufflet: shuffling sequences while conserving the k-let counts. Bioinformatics. 1999. 15(12): 1058-59.	60-77
X	Crameri A et al. DNA shuffling of a family of genes from diverse species accelerates directed evolution. Nature. 1998. 391: 288-291.	1,3,4-14, 30-33,47
X	Giver L and Arnold H. Combinatorial protein design by <i>in vitro</i> recombination. Curr Opin Chem Biol. 1998. 2: 335-338	1,3,4-14, 30-33, 47
X	Zhao H et al. Molecular evolution by staggered extension process (StEP) <i>in vitro</i> recombination. Nature Biotech. 1998. 16: 258-61.	
X	Patten P et al. Applications of DNA shuffling to pharmaceuticals and vaccines. Curr Opin Biotech. 1997. 8: 724-33	1, 3, 4-14, 19-33, 47
X	Fisch I et al. A strategy of exon shuffling for making large peptide repertoires displayed on filamentous bacteriophage. Proc Nat Acad Sci USA. 1996. 93: 7761-66	1, 2, 4-14, 30-33, 47
X	Stemmer WPC. DNA shuffling by random fragmentation and reassembly: <i>in vitro</i> recombination for molecular evolution. Proc Nat Acad Sci USA. 1994. 91: 10747-751.	1-18, 30-33, 47
X	Stemmer WPC. Rapid evolution of a protein <i>in vitro</i> by DNA shuffling. Nature. 1994. 370: 389-391.	1, 2, 4-14, 30-33

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU01/00622

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
WO 00/18906 A.	AU 11990/00 EP 1117777	WO 99/41369 A.	AU 26741/99 AU 26742/99 AU32891/ 99 AU 32910/99
WO 99/41402 A.	AU 26742/99 AU 32891/99 AU 32910/99 EP 1053312 EP 1053343 EP 1054973		EP 1053312 EP 1053343 EP 1054973 EP 1056842
		WO 99/41368 A	AU 26741/99 AU26742/99 AU 32891/99 EP 1053312 EP 1053343 EP 1056842
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